Power Engineering

DECEMBER, 1952

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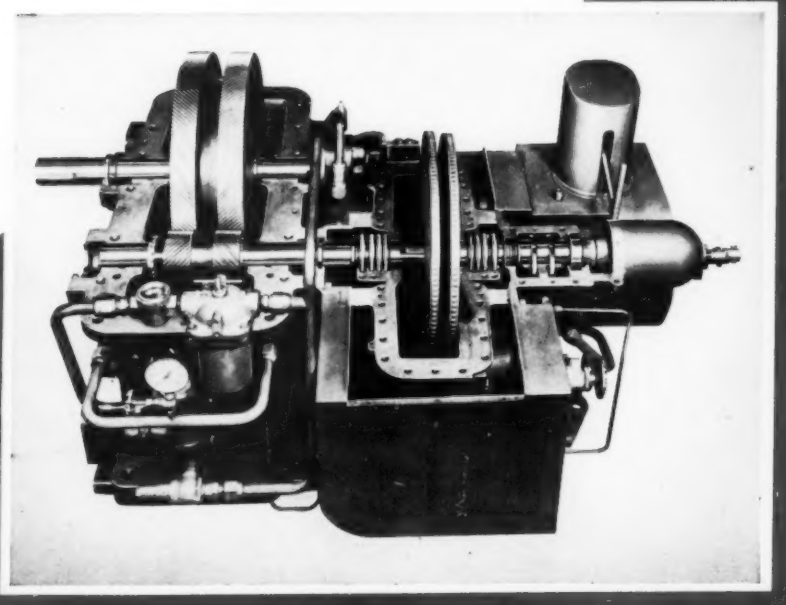
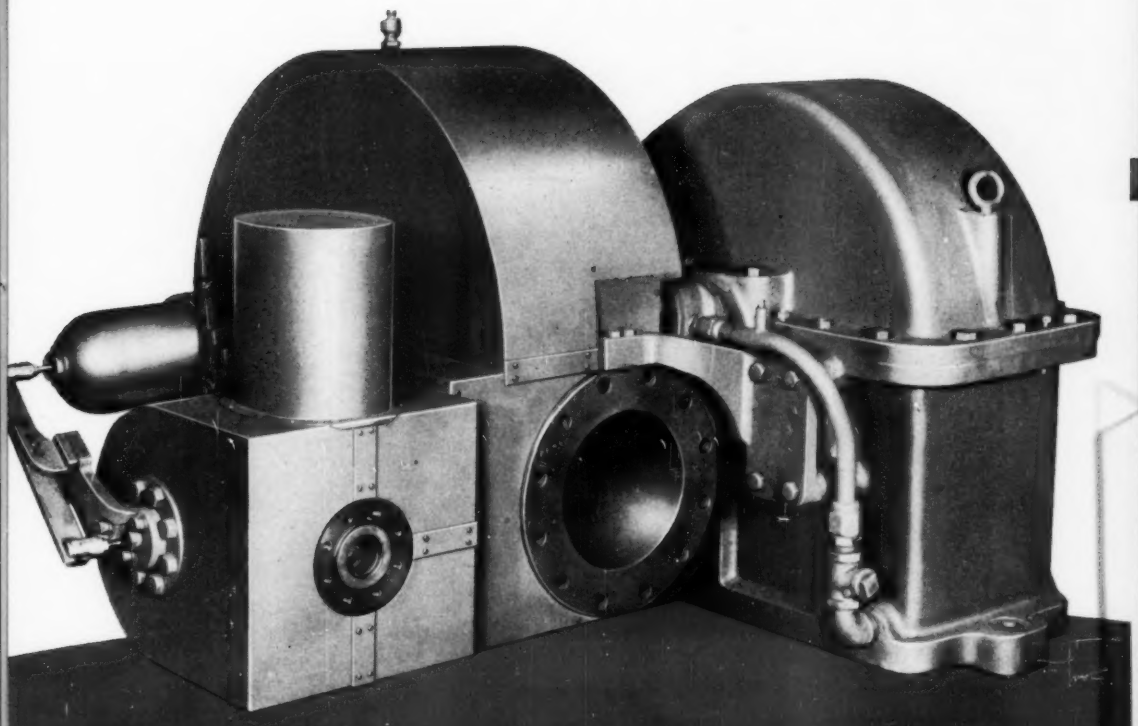
TECHNICAL PUBLISHING COMPANY

NEW ELLIOTT Geared Turbine

• The new line of Elliott reduction gears is available in either built-in or coupled designs. *Built-in* units have turbine and gear case firmly secured together, with turbine wheels and pinion mounted on the same sturdy high-speed shaft. Exhaust end turbine bearing and pedestal as well as the high-speed coupling are eliminated. This results in a compact unit of minimum overall length. The *coupled* reduction gear is a separate and self-contained unit, with pinion shaft flexibly coupled to the turbine and gear shaft flexibly coupled to the driven machine.





THE TURBINE

The new "built-in" Elliott geared turbine employs the sturdy and dependable YR turbine. This proved turbine design is adaptable to practically all operating requirements and is economical in both operation and maintenance.

Outstanding features are centerline support, stainless steel turbine buckets and shroud, dynamically balanced rotors, and the choice of several governors to be used with the standard overspeed governor. The wide use of standardized parts that fit all sizes of YR turbines simplifies maintenance and the stocking of parts.

Full details on the new Elliott Geared Turbines are given in Bulletin H-19, just released. Bulletin H-16 describes the YR turbine line. Contact your local Elliott district office or write Elliott Company, Jeannette, Pennsylvania.

THE GEARS

Gear and pinion are double-helical (herringbone) type, precision-hobbed, quiet, and long wearing. Tooth spacing is held to extremely close tolerances. Conservative proportioning of the teeth minimizes pinion deflection and permits a uniform, low tooth load.

Both the high-and low-speed gear shafts are provided with an oil slinger combined with a special seal. This design prevents leakage of oil from the gear case and eliminates the infiltration of water, steam, or impurities into the gear case.

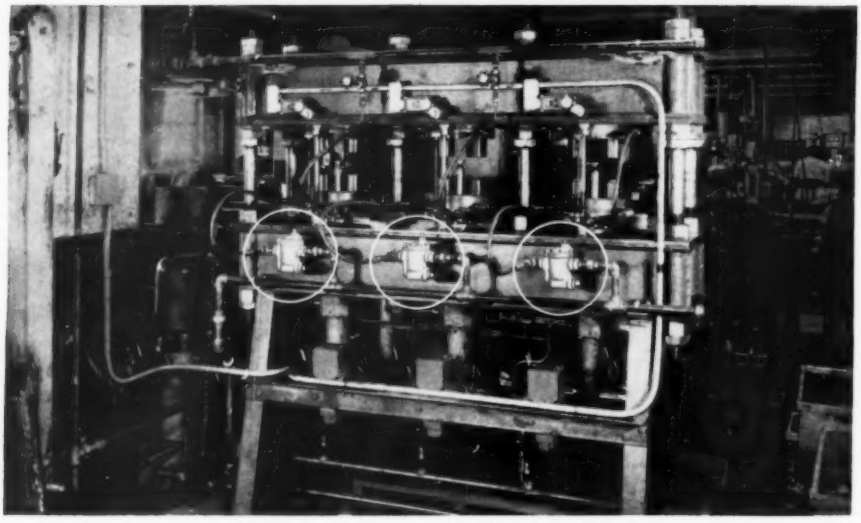
All Elliott gears, built-in or coupled, include a self-contained, forced-feed lubrication system which circulates oil under pressure to both gear and turbine bearings. In addition, two spray nozzles in the top gear casing direct a sheet of oil continuously into the meshing point of the gear and pinion teeth, cooling the teeth and lubricating the contact area.

ELLIOTT Company

STEAM TURBINE DEPT.

H34

Relies on Armstrong "Unit Trapping" to maintain molding press temperatures within ±5°F.



Uniform molding temperatures reduce leather cup rejects by 40%!

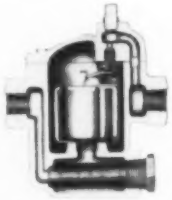
MANY a plant has accepted erratic temperatures of steam heated equipment as a necessary evil. Not so at Albert Trostel & Sons Company, Milwaukee, manufacturers of molded synthetic rubber and leather parts. They unhesitatingly replaced an electrically heated molding press, that varied in temperature as much as 30°F., with a steam heated press because they knew from previous experience that Armstrong Unit Trapping would give them uniform temperature control. Their confidence was not misplaced. An indivdual Armstrong steam trap on each station of the press keeps temperatures uniform within plus or minus 5°F. Molded leather cup rejects have been reduced by 40% and production greatly increased.

The benefits of Armstrong Unit Trapping are easy to understand. First, if you drain more than one unit with a single trap, any variation in pressure between the units will cause condensate and air from a higher pressure unit to block drainage from a slightly lower pressure unit or section. With an individual trap on each unit this cannot happen. Secondly, Armstrong traps discharge condensate and air as fast as they accumulate so that every unit is always full of hot dry steam and, hence, at maximum temperature.

Let your local Armstrong Representative look over your condensate drainage system—he sells Armstrong traps under a *satisfaction-or-your-money-back guarantee.* Call him or write:

ARMSTRONG MACHINE WORKS
810 Maple Street • Three Rivers, Michigan

BONUS VALUE



Built-in Strainer Trap Saves Money, Maintenance

Small traps need strainer protection against dirt and scale. Howard Knoller, V.P. & Plant Engineer of Albert Trostel & Sons Company, uses and likes Armstrong No. 880 traps with built-in strainers because: they cost less than a trap plus separate strainer; save fittings and installation labor, and the strainer can be cleaned without removing trap or shutting off steam.

You Always Get Greater Efficiency When You Use Armstrong Unit Trapping

FREE
44-PAGE
STEAM TRAP BOOK
Gives Complete Data

FILL IN AND CLIP TO YOUR COMPANY LETTERHEAD

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Title .....

For more data circle 502 on Post Card

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DECEMBER 1952
VOL. 56 • NO. 12

Complicated interpole, compounding and compensating field windings are clearly shown in this large Westinghouse Corp. d-c machine stator

Power Engineering

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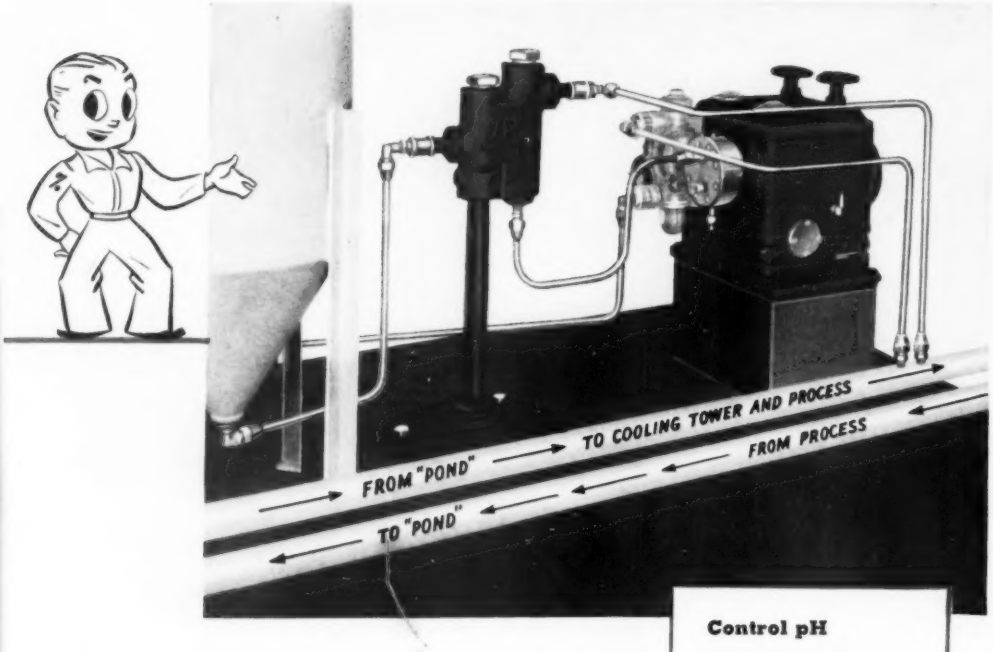
The only magazine devoted exclusively to the job interests of power engineers

HERE'S POSITIVE *Chemical Control* FOR YOUR COOLING WATER SYSTEM



Injection of treating chemicals into the line supplying water from the "pond" to the cooling tower prevents formation of slime and algae, and maintains the most efficient operating conditions throughout the cooling system. The chemicals are fed automatically at a constant, predetermined rate, or flow responsively in accordance with makeup demand. If a pH-responsive system is desired to maintain the optimum pH conditions, the metering pump can be readily adapted to this control. The Chem-O-Feeder in this "package" is a diaphragm-type unit, which can be supplied with one, two, or three measuring chambers, each having a maximum capacity of ten gallons per hour at pressures up to 100 psig. As many as three different chemicals can be handled at the same time. When equipped with an indirect displacement unit, the Chem-O-Feeder readily feeds hard-to-handle chemicals used in cooling water treatment.

Ask for recommendations and descriptive literature

Control pH

Prevent slime build-up

Eliminate down-time for cleaning

Increase cooling efficiency

Prolong equipment life

Reduce pumping costs

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Write to %PROPORTIONEERS, INC.%, 385 Harris Ave., Providence 1, R. I.

Technical service representatives in principal cities of the United States, Canada, Mexico and other foreign countries.

For more data circle 503 on Post Card

ENGINEERS' PREVIEW

POWER ENGINEERING readers who have been interested in the Equivalent Valves Manual, various editions of which have been announced in these pages, have sometimes had a little trouble in making contact direct with the publisher of this manual, The Equivalent Valves Co., as announced in our February 1952 issue.

In that issue, a very small error in the address may have caused this difficulty. Correct address is Equivalent Valves Company, P. O. Box 816, Station H, Los Angeles 44, Calif., and the company is still publishing and distributing the Equivalent Valves Manual and its revisions. (We originally published the wrong station letter, which led to some difficulty getting mail delivered to the company.)

★ ★ ★

GEOTHERMICS in New Zealand will be the next important development in this interesting field of steam power, according to a recent Reuters dispatch from Auckland, New Zealand. This development will be somewhat along the lines of the development of steam wells in the earth at Larderello, Italy, as described in Geothermics in the News Reel, POWER ENGINEERING, September 1952.

Purpose, same as in Italy, is to develop enough electricity from underground steam sources to make up for shortage of hydroelectric power. Engineers estimate that between 1960 and 1970, the generating capacity of the North Island System in New Zealand will be approximately 1,500,000 kw. After that the probable hydroelectric developments might be not more than about 250,000 kw in 10 or 12 stations. Accordingly, if more power is needed, it may be possible to obtain it from a location known as Wairakei, where there are natural steam deposits.

At Wairakei engineers are drilling wells for an experimental 20,000 kw power generating plant and William Stanley Goosman, Minister in Charge of Hydroelectric Department, has told Parliament that a much bigger field can be exploited there than at Larderello, which is now producing about 75 per cent of the Larderello area's power needs. Power engineers will watch this New Zealand development with a great deal of interest.

★ ★ ★

HOTTEST POWER NEWS of the year: This General Electric generator rotor will be turned by a turbine which uses the highest steam temperatures ever used in a turbine-generator. It will have a capacity of 145,000 kw. Shown just before leaving the Schenectady turbine shop of G-E, the rotor is being delivered to the Kearny, N. J. generating station of Public Service Electric and Gas Co. It is 32 ft long and weighs 100,000 lb. Use of higher steam temperatures in turbine-generators is one way in which G-E designers are helping electric companies burn less fuel per kilowatt-hour of electricity and thus reduce operating costs. The turbine for this generator will operate at an initial temperature of 1100 F, at 2350 psi. The unit is one of the first 3600-rpm machines generating at 20,000 volts.

★ ★ ★

LATEST DEVELOPMENTS in plastic patching for steel piping and an improved technique for developing better diesel fuels are described in government reports reviewed in the current (September) issue of the Technical Reports Newsletter, released by the Office of Technical Services, U. S. Department of Commerce.

Also discussed are pamphlets for the shopman on machining aluminum; selecting the right steel for stamping, rolling and milling operations; and methods of spraying on metal coatings (metallizing).

Single copies are available without charge from the Office of Technical Services of the U. S. Department of Commerce, Washington 25, D. C. or from the U. S. Department of Commerce field offices.

★ ★ ★

USE OF TELEVISION to observe the interior of furnaces of steam generators in power plants has proved successful and aids in maintaining efficient operation, it was reported at a power generation session, Fall General Meeting AIEE.

The report was made by L. M. Exlew, Long Island, N. Y. Light Co., engineer, who told about the novel use of television at the company's Port Jefferson, L. I. generating plant for the past 18 months. The television camera was placed in an opening at the top of two pulverized coal and oil fired furnaces and recorded changes that occurred during different stages of combustion. The camera lenses were protected by water and air-cooled glass.

Video has proved a helpful aid and does give a more complete story of furnace conditions than has heretofore been made available by other means. It has also been of educational value, helping train men who previously had little opportunity to see what happens in a lighted furnace.

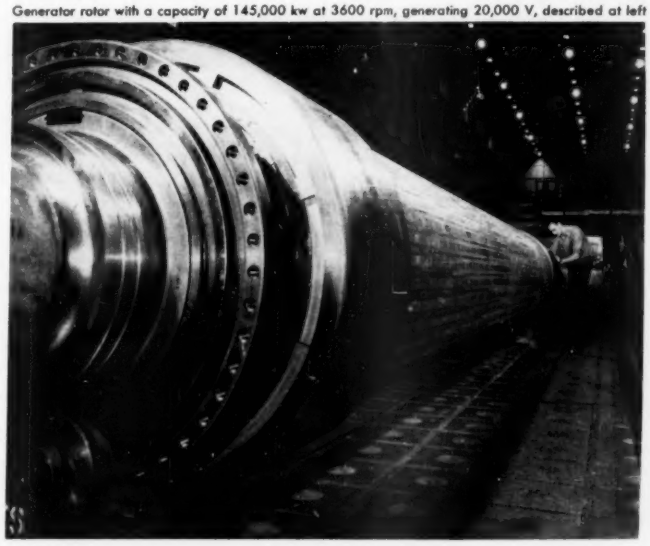
Television helps counteract one of the disadvantages of remote centralization of steam generating instruments, giving the operator a picture of what goes on in a furnace and a greater sense of reality with respect to the tremendous amount of energy under his control.

★ ★ ★

A NON-PROFIT FOUNDATION for scientific research in pure and applied science will be established by the Bjorksten Research Laboratories, industrial research organization with offices in Madison, Chicago, Washington, D. C., New York and Houston.

The Bjorksten Research Foundation has been formed to explore and develop findings which do not have an immediate

Generator rotor with a capacity of 145,000 kw at 3600 rpm, generating 20,000 V, described at left



commercial application, but which, rather, strike at fundamentals. The biochemical changes observed in the aging of living tissues, for example, will be among the problems scheduled for foundation study.

A secondary purpose of the new foundation is to help provide the means by which scientific discoveries, inventions, and processes may be developed, applied and patented, and their public and commercial uses determined or developed. In this connection, the foundation will accept assignments or inventions or interests in them, gifts, bequests, and it will enter into contracts or trust agreements with inventors, patent owners or applicants.

* * *

Babcock & Wilcox Co. has purchased facilities of a former shipyard from the Brunswick Port Authority at Brunswick, Ga., and will convert it into a plant to build boilers.

The property involved consists of about 110 acres with about 25,000 square feet under roof and was formerly the J. A. Jones shipyard before being acquired by the Brunswick Port Authority in 1945. The plant has not been used since the end of shipbuilding and will require considerable rehabilitation. This work, together with installing the necessary new equipment, will start immediately, and production will start first of the year.

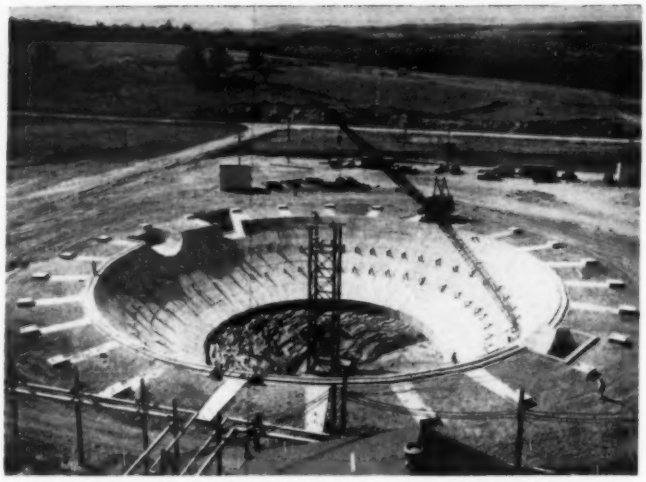
* * *

Components of one of the important power plants in your future are shown in these two illustrations. Saucer-shape foundation for the 225-ft steel sphere that is to house a nuclear submarine power plant being built by the Atomic Energy Commission for the U. S. Navy and work on assembling the hull of the land-based prototype submarine is underway, the Schenectady Operations Office of the AEC and the General Electric Company jointly announced October 17.

Known as the Submarine Intermediate Reactor (SIR), this project is under the direction of the Knolls Atomic Power Laboratory operated at Schenectady for the AEC by the General Electric Company. The reactor, and the sphere enclosing it, are being built on a 4,000 acre site at West Milton, N. Y., about 18 miles north of Schenectady.

The spherical design of the reactor building was adopted to give additional protection to operating personnel and to off-site areas during test operations beyond the many safety controls of the reactor itself.

The outer periphery of the building will be 706 feet. The sphere will rest on the concrete saucer just completed which is 179 feet in diameter and 42 feet deep. A ring of steel columns set on concrete outside the structure and reaching to the middle of the sphere will give further support to the building. Welded steel plates will make up the skin of the ball.



Saucer-shape foundation for the 225-ft steel sphere that is to house a nuclear submarine power plant

The plates will be hoisted into position by a derrick mounted on top of a temporary central steel tower. The derrick, now in place, reaches up 424 feet above ground level.

Every weld in the structure must be X-rayed to assure that there are no leaks. To do this on the bottom, a four-foot space is provided temporarily between the base of the sphere and the concrete saucer. After testing is completed, this space will be filled with concrete and aggregate. Inside, the concrete floor on which the reactor will rest will be slightly above ground level and the well of the saucer beneath the floor will be filled with compacted mixture of aggregate and earth.

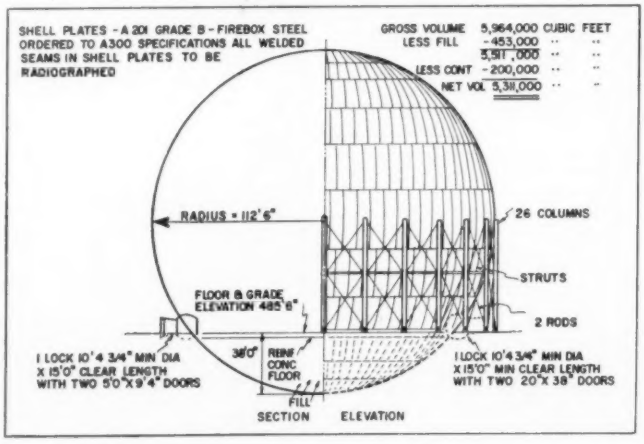
As soon as the columns are in place, the first ring of plates will gird the sphere at its center and assembly will proceed both upwards and downwards.

Meanwhile the hull of the submarine will be assembled just outside the building and when the latter is completed and tested, the hull will be skidded into the huge ball through a special wall section and the sphere again sealed.

The reactor designed for the West Milton site will use liquid sodium metal to take the heat out of the reactor core and into an exchanger or "boiler" where water will be converted to steam. The steam will then drive turbines that propel the submarine.

Design, testing and scientific support of the SIR comes from the Knolls Atomic Power Laboratory staff. The Electric Boat Division of the General Dynamics Corporation of Groton, Connecticut, is erecting the hull and power plant. The sphere-shaped building for the reactor is being built by the Chicago Bridge and Iron Company.

Hortonsphere for nuclear submarine power plant which goes in foundation shown in the picture above


SHELL PLATES - A 201 GRADE B - FIREBOX STEEL ORDERED TO A300 SPECIFICATIONS ALL WELDED SEAMS IN SHELL PLATES TO BE RADIOGRAPHED
GROSS VOLUME 5,964,000 CUBIC FEET
LESS FILL -453,000 " "
5,511,000 " "
LESS CONT -200,000 " "
NET VOL 5,311,000 " "
RADIUS = 112'6"
26 COLUMNS
STRUTS
2 RODS
FLOOR @ GRADE ELEVATION 485'8"
36'0"
REINF CONC FLOOR
FILL
1 LOCK 10'4 3/4" MIN DIA X 15'0" CLEAR LENGTH WITH TWO 5'0"X9'4" DOORS
1 LOCK 10'4 3/4" MIN DIA X 15'0" MIN CLEAR LENGTH WITH TWO 20"X 38" DOORS
SECTION
ELEVATION

RESEARCH AND USE PROVED QUALITY OF SUN ELECTRICAL OILS

Constant research has enabled Sun to keep pace with the ever-changing requirements of the fast-moving electrical industry. Used for years by leading manufacturers of cables, capacitors and transformers, Sun Electrical Oils have been "Job Proved" under actual operating conditions. This combination of laboratory research and field experience assures you of completely dependable products that satisfy the most rigid electrical requirements.

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3. HIGH RESISTANCE TO OXIDATION—due to choice of crude stocks and method of refining, Sun Electrical Oils have high stability, and as a result, oxidation is minimized.

4. LOW POUR POINT—an inherent quality that assures fluidity under most operating conditions.

5. FREEDOM FROM CORROSIVE ACIDS AND CORROSIVE SULFUR—helps prevent deterioration of cable materials.

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2. HIGH DIELECTRIC STRENGTH—due to complete freedom from solid and liquid impurities.

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4. HIGH RESISTANCE TO OXIDATION—because Sun Electrical Oils, as produced, are free of impurities and possess high degree of stability, oxidation is minimized throughout their life.

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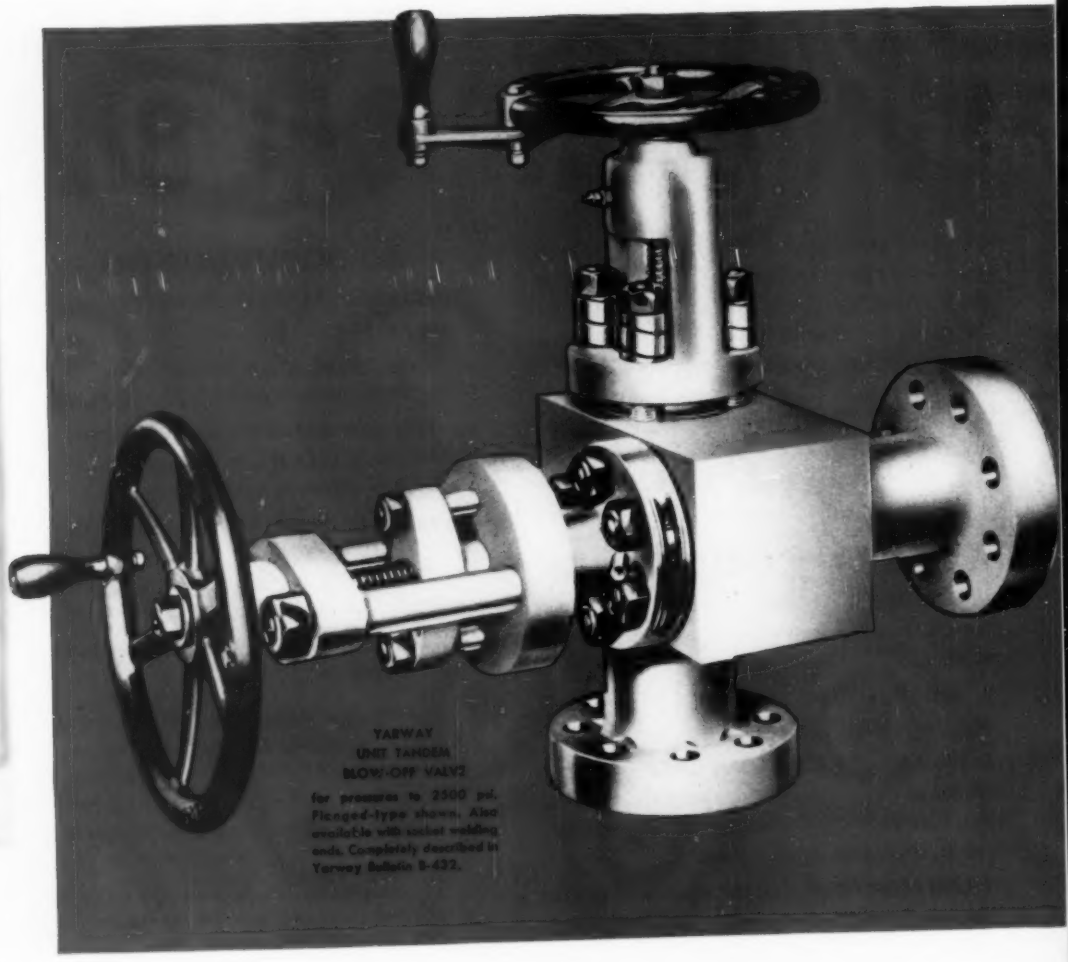

YARWAY
UNIT TANDEM
BLOW-OFF VALVE
for pressures to 2500 psi. Flanged-type shown. Also available with socket welding ends. Completely described in Yarway Bulletin B-432.

YARWAY

IS WORTH A *GOOD* BLOW-OFF VALVE

Boilers represent sizable investments . . . certainly worth protecting with the most dependable boiler trim you can get.

You need good blow-off valves—valves that keep blow-down lines tight, don't wear, clog or leak, and are rugged enough to stand up under the severe shock of regular or emergency blowing-down under pressure.

Yarway Blow-Off Valves meet those requirements. Both Yarway Seatless Valves with balanced sliding plunger, and Yarway Stellite-faced Hard-Seat Valves embody the most recent developments in design and metallurgy.

Engineers tell us the sturdiest of all blow-off valves is the Yarway Unit Tandem. This famous valve combines either a seatless and hard-seat, or two hard-seat valves, in a one-piece forged steel body. It is made for pressures up to 2500 psi. Other Yarway Blow-Off Valves meet lower pressure requirements.

It is significant that more than 15,000 plants throughout the world use Yarway Blow-Off Valves . . . and among the higher pressure plants, 4 out of every 5 are Yarway-equipped!

A Yarway bulletin will tell you in detail how these valves can protect *your* boiler investment. Write today, stating pressure range.

YARNALL-WARING COMPANY, 114 Mermaid Avenue, Philadelphia 18, Pa.

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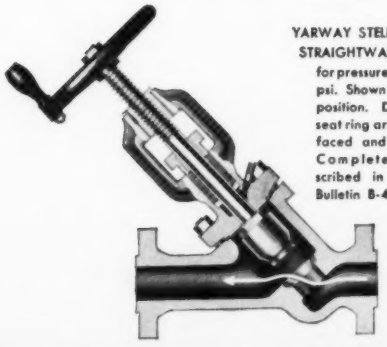
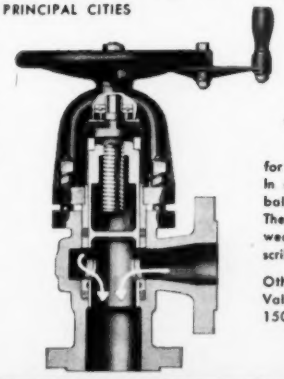


YARWAY STELLITE-SEAT STRAIGHTWAY VALVE for pressures to 2500 psi. Shown in open position. Disc and seat ring are stellite-faced and ground. Completely described in Yarway Bulletin B-432.



YARWAY TYPE "B" SEATLESS ANGLE VALVE for pressures to 400 psi. In open position. Notice balanced sliding plunger. There is no seat to score, wear, clog or leak. Described in Bulletin B-424.

Other Yarway Seatless Valves for pressures to 1500 psi.

For more data circle 505 on Post Card

WA-Series

STEAM TURBINE GENERATOR UNIT

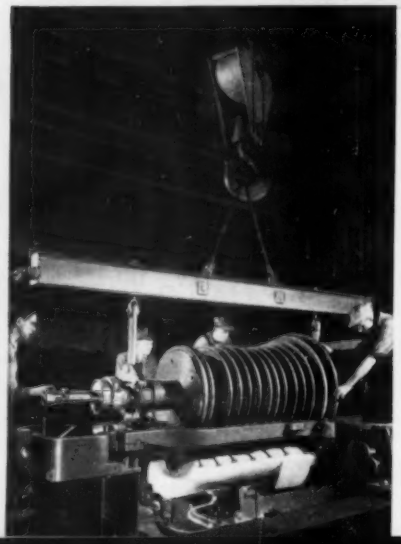
From Shop

HERE'S HOW Allis-Chalmers Builds the Generator Unit that's Easy to Install, Low in Foundation Cost

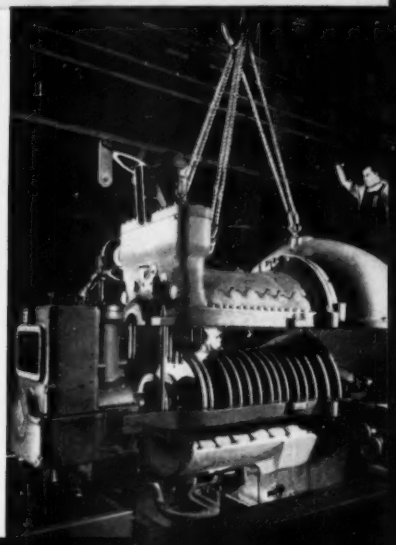
MODERN Allis-Chalmers WA-Series steam turbine generating units are factory tested and shipped with rotors locked in place to save you installation time. Oil piping and generator air coolers are both above the floor line to reduce your foundation costs.

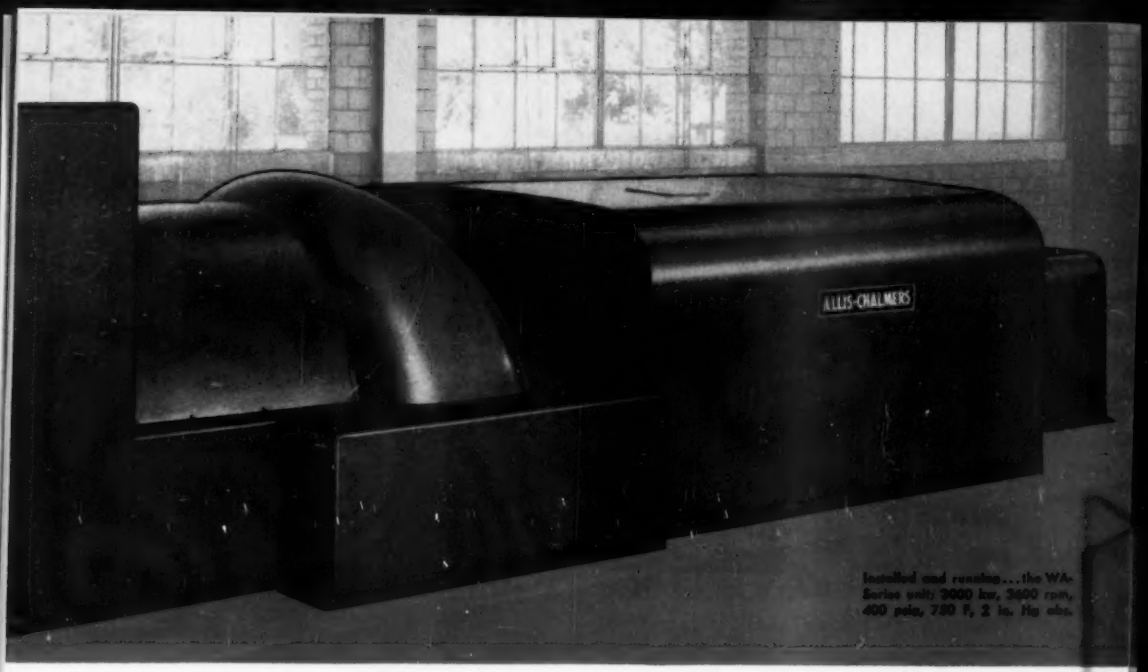
WA-Series units are built in ratings from 2000 to 7500 kw for either condensing or non-condensing operation. For your copy of Bulletin 03B7654, call your nearest A-C office or write to Allis-Chalmers, Milwaukee 1, Wisconsin. A-3910

1 Precision balanced turbine rotor assembly being lowered into casing. All wheels have durable chrome alloy steel buckets.



2 Upper half casing of this compact impulse steam turbine is next added in the process of assembling the WA-Series unit.



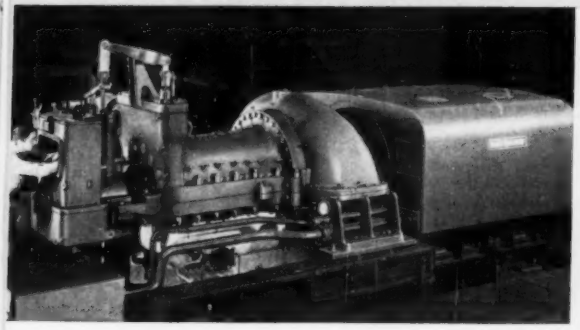


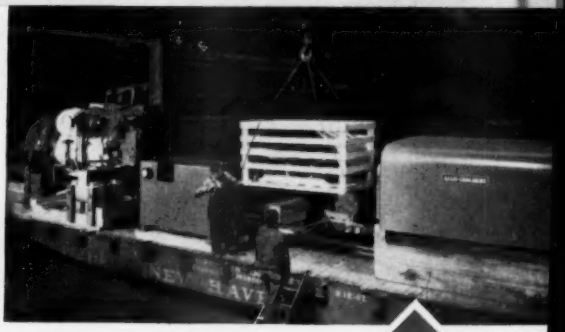
Installed and running... the WA-Series unit: 3000 kw, 3600 rpm, 400 pole, 750 F, 2 in. Hg abs.

to Shipment!

3 Assembled 3-bearing unit — complete with housing type air cooled generator — ready for factory testing. **Both oil piping and generator air coolers are above the floor line.**

4 Entire WA-Series 3000-kw unit—pre-tested and insulated—being loaded on **one** flatcar for unit shipment. Both turbine and generator are shipped with their rotors **securely locked in place.**

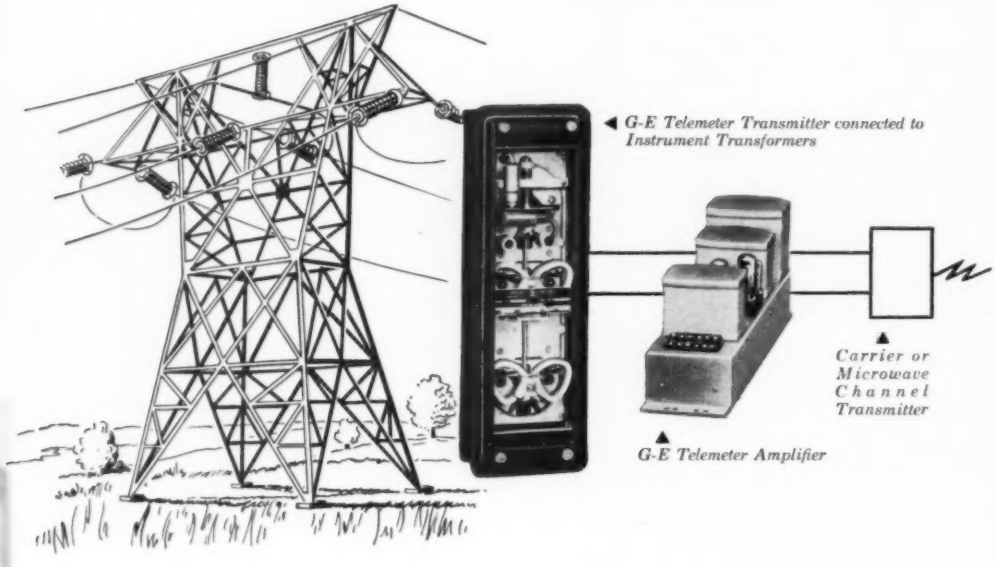




ALLIS-CHALMERS

World's Widest Range of Power Plant Equipment

A-C ALLIS-CHALMERS


G-E Telemeter Transmitter connected to Instrument Transformers
Carrier or Microwave Channel Transmitter
G-E Telemeter Amplifier

See every load change

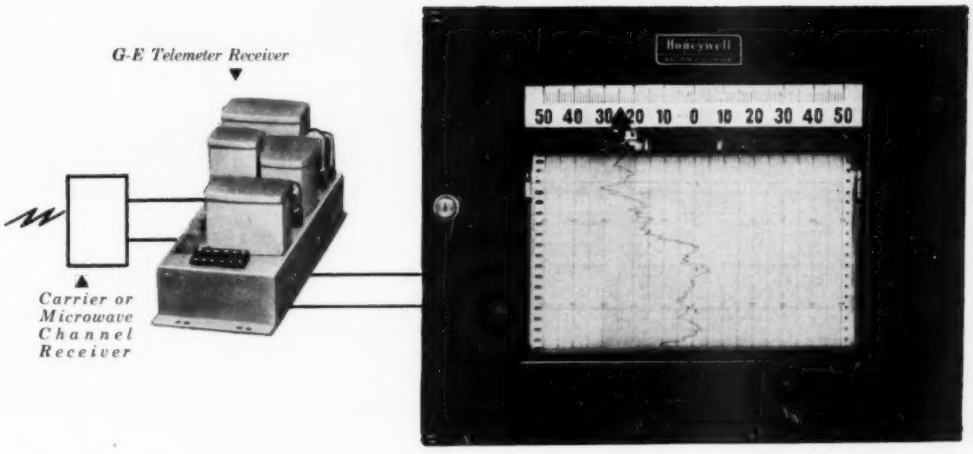
Flexibility... Dependability... for all power plant measurements

The versatile *ElectroniK* Recorder is applicable to measurement of pressure, flow, speed, pH, conductivity, power, current, temperature . . . the *same basic instrument for all*, with changes only in measuring circuit and sensing elements. Use of standard, interchangeable components simplifies maintenance, reduces parts-stocking problems. Single-point and multi-point models are available in a choice of printing speeds, and with chart speeds from $\frac{1}{2}$" to 120" per hour.

The utmost in dependability demanded by power plant applications is insured by *ElectroniK* components . . . life-tested, service-proved, designed for minimum, easy maintenance. These rugged "building blocks"—the high-torque balancing motor, the hermetically sealed converter, the simplified continuous-balance amplifier—typify construction that minimizes the number of moving parts, and that eliminates troubles from dust and atmospheric humidity.

● *Important Reference Data*

Write for Instrumentation Data Sheet No. 9.1-10, "Long Distance Transmission of System Variables"... and for



ElectroniK Recorder

General Electric frequency-type telemetering system with ***ElectroniK*** *strip-chart recorder*

the instant it happens...

through continuous telemetering with ElectroniK RECORDERS

THE ultra-fast telemetering equipment shown above keeps the load dispatcher in constant touch with all parts of the system. It tells him every change in tie line interchange, in station generation and in system load—the instant that a change takes place. Operating over carrier current or microwave channels, it spans distances of hundreds of miles . . . eliminates the delays and uncertainties of intermittent, non-continuous measurement.

The *ElectroniK* recorder presents load data in full, readable detail on its big, 11-inch-wide strip chart, where every significant change and trend stands out for the dispatcher's attention. The rapid response of *ElectroniK* continuous-balance measuring assures full utilization of the inherent speed of the telemetering equipment. And the industry-proved dependability of *ElectroniK* construction means absolute minimum maintenance, and uninterrupted performance.

Your local Honeywell engineering representative will be glad to give you full details. Call him today—he is as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4587 Wayne Ave., Philadelphia 44, Pa. Service available promptly from more than 55 offices in principal cities of the United States.

MINNEAPOLIS
Honeywell
BROWN INSTRUMENTS
First in Controls

Bulletin 90-2, "Supervisory Instruments for Power Generation."

For more data circle 507 on Post Card

Industries served by VU Boilers

Aircraft
Asphalt
Automobile
Breweries
Building Materials
Carpet
Cellophane
Cement
Chemical
Coal Mining
Coke
Cold Storage
Dairy
Department Stores
Distilling
Explosives
Electrical Equipment
Electric Power
Food Products
Foundries
Gas Works
Gelatine
Glass
Hosiery
Knitting Mills
Institutions
Laundries
Leather
Linoleum
Locomotive
Lumber
Machinery
Metal Producing
Mining
Municipal
Oil Refining
Paint
Paper
Public Utilities
Radio
Railways
Refrigeration
Rubber
Schools
Sewage Plants
Shipbuilding
Sugar
Textile
Tobacco
U. S. Government

VU – a popular choice PERFORMANCE counts

It is significant to steam users to know that in virtually every industry, leading companies are using C-E Vertical Unit Boilers. And it is of even greater significance that with leading *utilities* too, VU Boilers have been a popular choice for many years. For boilers are a major part of the manufacturing operation of power companies and their economy and reliability *directly* affect costs and profits.

You would expect then that utilities would evaluate boiler design and construction . . . exhaustively and critically. And they do. Moreover their buying decisions reflect their experience that the first cost of a boiler is far less important than annual fuel and operating costs. They therefore place special stress on features which will assure the utmost operating economy consistent with reliability.

That they find such features in Vertical-Unit Boilers is evident from the record. Leading utilities from coast to coast have bought VU Boilers and have reordered them again and again. In fact, 54% of all utilities now using VU Boilers have two or more of them in service.

You too can discover, as leading utilities have, that Vertical-Unit Boilers will give you that day-in-and-day-out economy and reliability essential to a maximum return on your boiler investment. VU Boilers are available for capacities from 10,000 to 350,000 pounds of steam per hour and are adaptable to any fuel or method of firing.

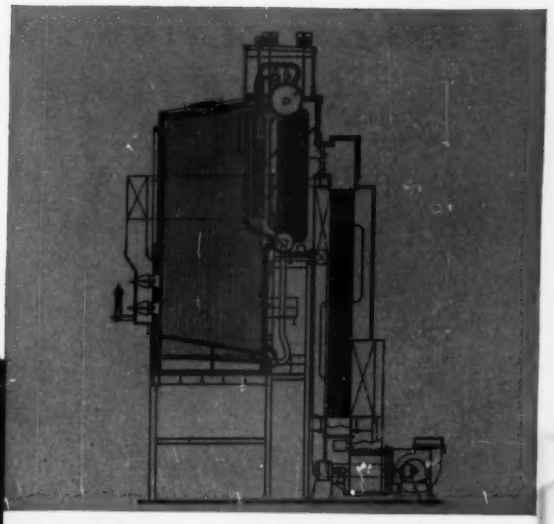
Partial List of Utility Companies Using

Atlantic City Electric Co.
California Electric Power Co.
Central Hudson Gas & Electric Co.
Central Illinois Public Service Co.
Dallas Power & Light Co.
Dayton Power & Light Co.
Florida Power & Light Co.
Interstate Power Co.
Kansas Gas & Electric Co.
Missouri Power & Light Co.

COMBUSTION ENGINEERING

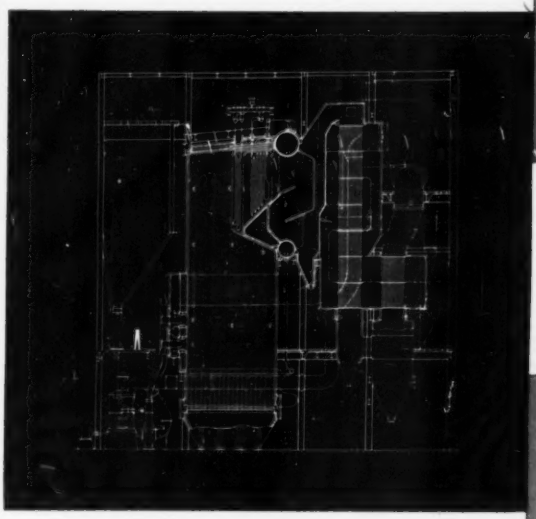
ALL TYPES OF BOILERS, FURNACES, PULVERIZED FUEL SYSTEMS AND STOKERS; ALSO SUPERHEATERS, ECONOMIZERS AND AIR HEATERS

where the most



VU-50 Boiler — This unit, installed in an electric generating station in Missouri, burns natural gas and oil. It is arranged for future coal firing. Capacity — 350,000 lb steam per hr; oper. press. — 920 psi; steam temp. — 905 F.

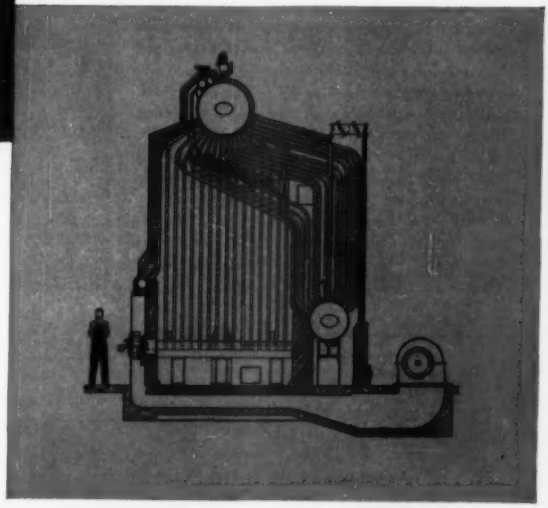
VU-10 Boiler — This unit, one of four duplicates, is in service in a New England utility plant. It is fired with oil or gas. Capacity — 45,000 lb steam per hr; operating pressure — 235 psi; steam temperature — 500 F.



VU-50 Boiler—One of two duplicates in service in a North Dakota station. Fires pulverized lignite, using C-E Raymond Bowl Mills and C-E Type R Burners. Capacity—230,000 lb steam per hr; oper. press.—865 psi; steam temp.—905 F.

Two or More VU Units

Narragansett Electric Co., The
New York State Electric & Gas Corp.
Northwestern Public Service Co.
Omaha Public Power District
Otter Tail Power Co., The
Savannah Electric & Power Co.
Southwestern Public Service Co.
Texas Electric Service Co.
Western Light & Telephone Co.
Western Massachusetts Electric Co.



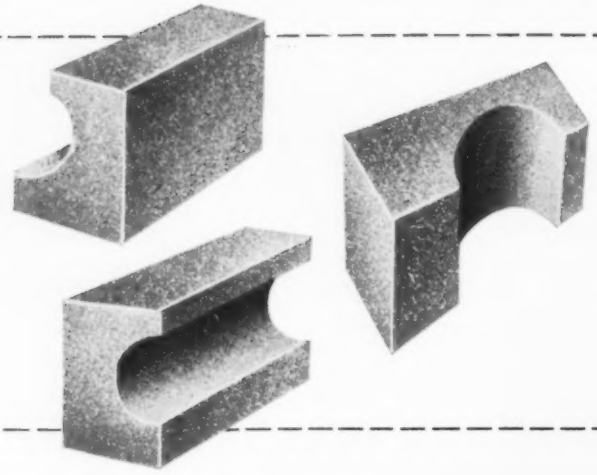
B-630

— SUPERHEATER, INC.
200 MADISON AVENUE, NEW YORK 16, N. Y.

C-E

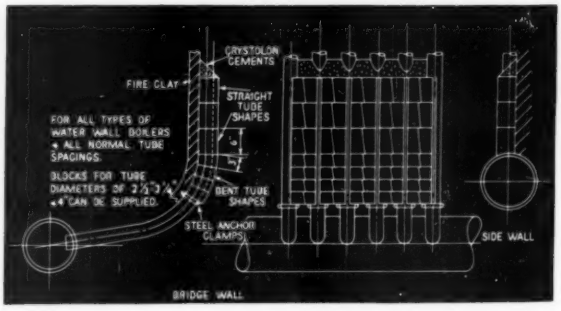
For more data circle 508 on Post Card

LASTING, LOW-COST PROTECTION
for Your Water Tube Boilers
with CRYSTOLON* Armor Blocks



Made Of Top-Quality Silicon Carbide, Norton CRYSTOLON Armor Blocks have the necessary refractoriness to withstand today's extremely high boiler furnace temperatures. Equally important is their high resistance to slag penetration and abrasion. Due to their high thermal conductivity, they promote even heat distribution, and afford maximum protection to tubes from localized heat generation and flame impingement.

Installation Is Easy And Inexpensive, thanks to the simplified design of CRYSTOLON Armor Blocks. Adjoining surfaces of blocks are tapered, for secure locking and to maintain intimate contact with the tubes. Available for both bent and straight tube sections, these blocks can be replaced entirely from the fire side of the boiler. They are laid dry, further reducing installation costs, and tubes require no cleaning or grinding, as when cast iron blocks are replaced. When small areas are to be protected against flame impingement, blocks can be held correctly in place by clamps fitted around the tubes.


CRYSTOLON CEMENTS
FIRE CLAY
STRAIGHT TUBE SHAPES
FOR ALL TYPES OF WATER WALL BOILERS & ALL NORMAL TUBE SPACINGS.
BLOCKS FOR TUBE DIAMETERS OF 2½"-3¼" & 4" CAN BE SUPPLIED.
BENT TUBE SHAPES
STEEL ANCHOR CLAMPS
SIDE WALL
BRIDGE WALL

Whatever type or make of water tube boilers you're using, you can depend on CRYSTOLON Armor Blocks for thorough protection and economy. For prices and full information, send data on tube diameters, tube spacing, radius of curvature in bent-tube sections, and dimensions of areas to be covered. Refractories Division, NORTON COMPANY, 626 New Bond Street, Worcester 6, Mass.

*Trade-Mark Reg. U. S. Pat. Off. and Foreign Countries

NORTON

Special REFRACTORIES

Making better products to make other products better

Canadian Representative
A. P. GREEN FIRE BRICK CO., Ltd. TORONTO, ONTARIO

For more data circle 509 on Post Card

Remember—the trade marks "tt" and "TUBE-TURN" are applicable only to products of TUBE TURNS, INC.

Engineered for extra strength

An important value you get with TUBE-TURN Welding Fittings and Flanges is extra strength . . . at no extra cost.

For example, this TUBE-TURN Welding Tee will withstand more pressure than required by standard codes . . . because it is drawn from seamless tubing to a barrel shape, and because of its generous crotch radius and thickness. Bursting pressures obtained in tests of representative fittings have averaged more than 25% higher than code requirements.

For this extra quality get in touch with your nearby TUBE TURNS' Distributor. You'll find one in every principal city.

Scrappy says: "Aid defense—more scrap today . . . more steel tomorrow."

Write Dept. C-12 for free booklet on Allowable Working Pressures. Use coupon on reverse side.

Be sure you see the double "tt"

TUBE TURNS, INC. LOUISVILLE 1, KENTUCKY

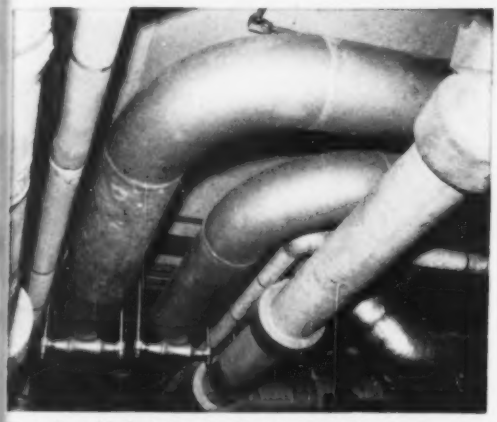
DISTRICT OFFICES: New York • Philadelphia • Pittsburgh • Chicago • Houston • Tulsa • San Francisco • Los Angeles
TUBE TURNS OF CANADA LIMITED, CHATHAM, ONTARIO . . . A wholly owned subsidiary of TUBE TURNS, INC.

EFFICIENT PIPING FOR STOCK EXCHANGE

Welded piping system serves New York Stock Exchange

Long the financial capital of the world, the New York Stock Exchange was one of the first commercial buildings to have controlled atmosphere. Recent additions provide efficient, modern air conditioning to keep the financial mart comfortable at all times.

New installations have been made with a minimum of fuss, in limited space, by use of compact welded piping systems. With TUBE-TURN Welding Fittings used to make directional changes, a permanently leakproof system is assured.



Use of welded piping simplified installation in cramped quarters. Welded lines can be fitted closely together, make a neat installation. Welders like to use TUBE-TURN Welding Fittings, because their consistent dimensional accuracy makes line-up easy, particularly important where space is at a premium.

These 10" and 14" lines carry condenser water to the building's cooling tower. Selection of TUBE-TURN Welding Fittings assures optimum flow conditions, and provides a permanently leakproof system.

Want Pressure Data?

Tube Turns, Inc. has prepared a booklet of pressure ratings covering TUBE-TURN Welding Fittings in all sizes, weights, and regularly manufactured materials for Power, Refrigeration, Gas, Oil, and Heating Piping. If you'd like a free copy just send the coupon.

TUBE TURNS, INC., Dept. C-12
224 East Broadway, Louisville 1, Kentucky

Your name .....

Position .....

Company .....

Nature of business .....

Address .....

City ..... *State* .....

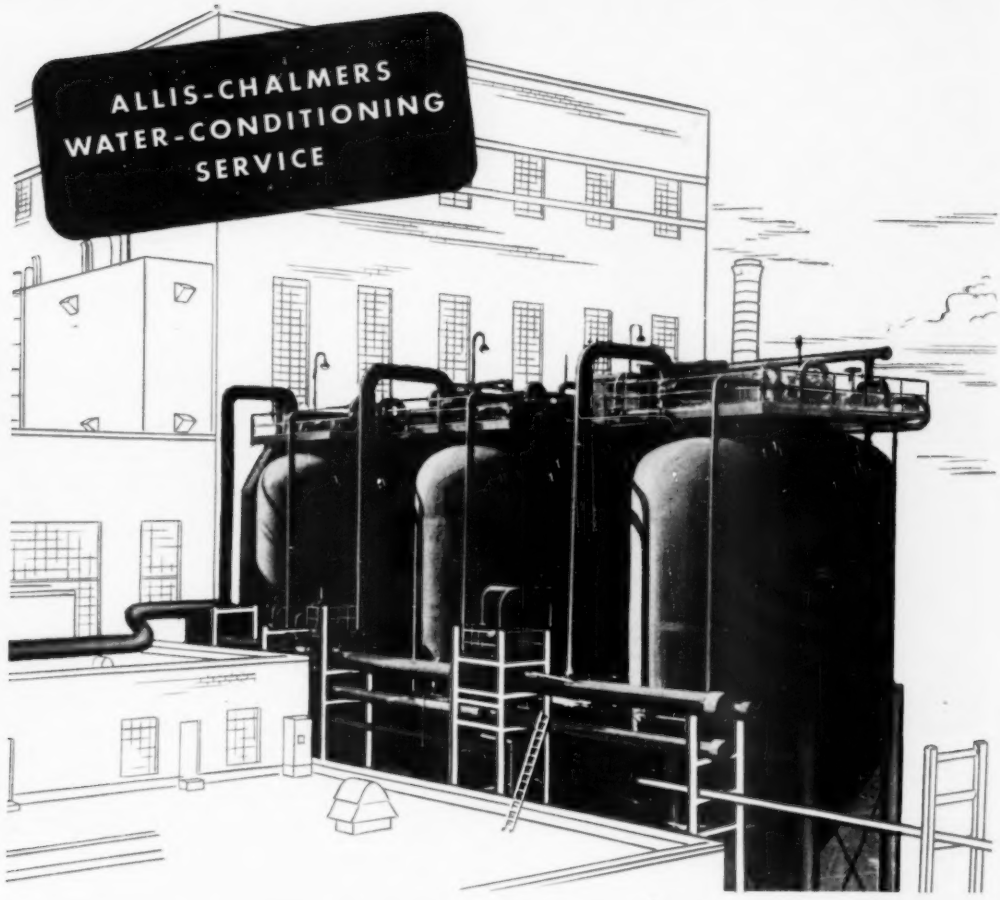
DISTRICT OFFICES

New York	Houston
Philadelphia	Tulsa
Pittsburgh	San Francisco
Chicago	Los Angeles

"tt" and "TUBE-TURN" Reg. U. S. Pat. Off.

TUBE TURNS, INC.

LOUISVILLE 1, KENTUCKY



WATER HARDNESS CUT TO ZERO

at record rate of 240,000 gallons per hour!

THIS king-size, outdoor water-softening system was recently installed by Allis-Chalmers to meet the special needs of a leading midwest oil refinery. It furnishes four high-pressure boilers with filtered treated water at the extraordinary rate of 240,000 gallons per hour — the largest water-softening system ever installed in a refinery power plant.

Extremely rugged and designed for year-round operation outdoors, this Allis-Chalmers system has been in service about four years. There have been no breakdowns, and maintenance costs have been practically nil.

Whatever *your* industry—paper, petroleum, food, steel—you'll get prompt, convincing results with Allis-Chalmers Water Conditioning service.

For over 50 years Allis-Chalmers has been building power generation equipment. This experience is invaluable in providing our water conditioning specialists with the extensive background needed today to recommend correct equipment, chemicals and service.

An expert representative is available, ready to recommend proper chemicals or help select the right process for your power plant requirements. For complete information, contact your nearby Allis-Chalmers District Office, or write Allis-Chalmers, Milwaukee 1, Wis.

A-3916

ALLIS-CHALMERS

GENERAL MACHINERY DIVISION

MILWAUKEE, WIS. — PITTSBURGH, PA. — NORWOOD, OHIO — BOSTON, MASS. — TERRE HAUTE, IND. — MONTREAL, P. Q. — ST. THOMAS, ONT.

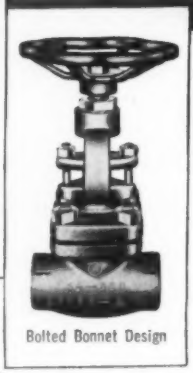
For more data circle 511 on Post Card

They've got what you want!

600# HANCOCK STEEL WELDVALVES

1. **"500 Brinell" Stainless Steel Disc and Integral Stellite Seat** — accurately finished, perfectly aligned — end valve seat leakage and replacement. No wire drawing, galling, steam cutting, erosion or corrosion.
2. **Maximum Use of Super-Strong, Leak-Proof Welding** to keep maintenance costs low.
3. **Stainless Steel Ball Bearing Stem-to-Disc Connection** for longer wear, even distribution of load, easy operation.
4. **Corrosion-Resistant Back Seating** permits stuffing box shut-off around the stem with valve fully open.
5. **Extra-Strong Upper Structure** — far stronger than conventional designs.
6. **Yoke Post and Gland Nut Threads Protected** permanently — always workable. Yoke post is chrome impregnated.
7. **Compact Design** saves space, permits close alignment of piping with near structures.
8. **Safe, Comfortable Handwheel** — designed to operator specifications.
9. **Completely Interchangeable Parts** — saves time, trouble, money.
10. **Special Treatment** resists corrosion of valve exterior.

"No Bonnet Joint" Design



Bolted Bonnet Design

600# Hancock Steel Weldvalves are built for trouble-free dependability in the severest services. Despite their long-life performance, they cost no more than ordinary valves. You get more for your money when you invest in Hancock Steel Weldvalves.

Made in globe and angle types, 600# Hancock Weldvalves are available for *all* pressures up to 850 P.S.I. at 750°F.—O.W.G. 2000#, 100°F. No bonnet joint in sizes ¼" through 2" and bolted bonnet designs in sizes 1¼" through 2" — screwed, socket weld and flanged ends.

Your nearby Hancock Valve Distributor has all the design and operational data that make these valves outstanding in service life and economy. Phone him for prompt attention to your needs.

When Hancocks go in, valve costs go down

HANCOCK VALVES

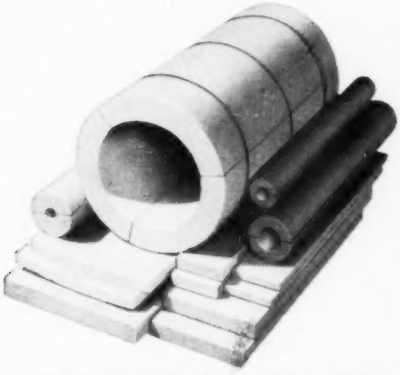
A product of **MANNING, MAXWELL & MOORE, INC.** WATERTOWN 72, MASSACHUSETTS

MAKERS OF 'HANCOCK' VALVES, 'ASHCROFT' GAUGES, 'CONSOLIDATED' SAFETY AND RELIEF VALVES, 'AMERICAN' INDUSTRIAL INSTRUMENTS. BUILDERS OF "SHAW-BOX" CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES.

For more data circle 512 on Post Card

Does Your Present Heat Insulation Have All These Advantages?

Kaylo Heat Insulation is a hydrous calcium silicate — a revolutionary heat-saving material — outstanding both in performance and ease of application.



KAYLO PIPE INSULATION is made to Simplified Dimensional Standards of thicknesses and diameters for snug nesting, when necessary.

1. **LOW "K" FACTOR**—Billions of sub-microscopic air spaces which compose the structure of Kaylo Heat Insulation give it exceptional insulating value.
2. **TEMPERATURE RANGE UP TO 1200° F.**—Kaylo Heat Insulation eliminates the need for combination coverings in nearly all operating conditions.
3. **LONG SERVICE LIFE**—Kaylo Heat Insulation remains dimensionally stable, strong and efficient over the years—although exposed to temperatures up to 1200°F.
4. **INSOLUBILITY IN WATER**—Even when saturated, Kaylo Heat Insulation retains about 85% of its strength. It returns to its original strength after drying.
5. **HIGH STRENGTH**—Breakage of Kaylo Heat Insulation is almost negligible in shipping and installation—workmen can walk on insulated equipment without causing breakage.
6. **LIGHT WEIGHT**—Since Kaylo Heat Insulation weighs only 11 pounds per cubic foot, it is exceptionally easy to handle and apply.
7. **WIDE RANGE OF SIZES AND SHAPES**—Kaylo Heat Insulation's unmatched selection of sizes and shapes reduces the number of pieces required per job.
8. **EASE OF CUTTING AND FITTING**—Ordinary tools of the trade are used to install Kaylo Heat Insulation. The material is non-irritating to the skin and non-toxic.

For complete details on all of the advantages of Kaylo Heat Insulation, write Dept. N-290, Owens-Illinois Glass Company, Kaylo Division, Toledo 1, Ohio.

SEE OUR CATALOG in SWEET'S FILE

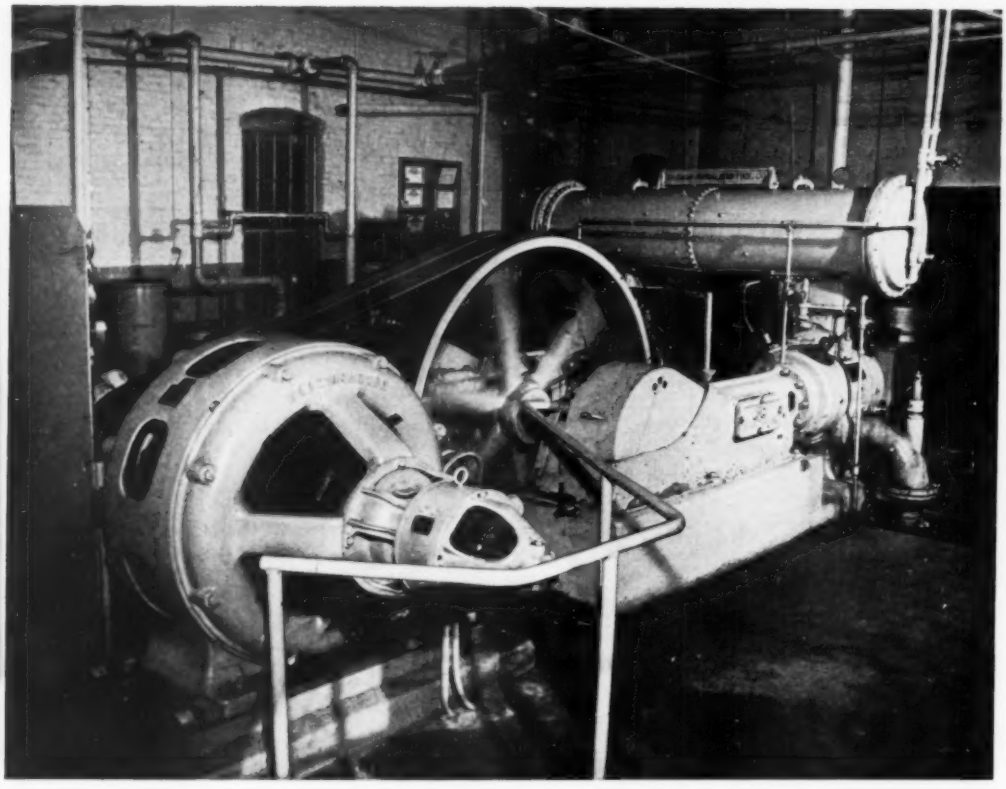
KAYLO® ... *first in calcium silicate*

...*pioneered by* OWENS-ILLINOIS Glass Company

MAIN OFFICE: TOLEDO 1, OHIO—KAYLO SALES OFFICES: ATLANTA • CHICAGO • HOUSTON • NEW YORK • PITTSBURGH • ST. LOUIS

For more data circle 513 on Post Card

"No Valve, Ring, or for Over 2 Years!"



The American Car and Foundry Company's huge plant at Huntington, West Virginia has been a user of Sinclair lubricants for over eighteen years. The results are of particular interest!

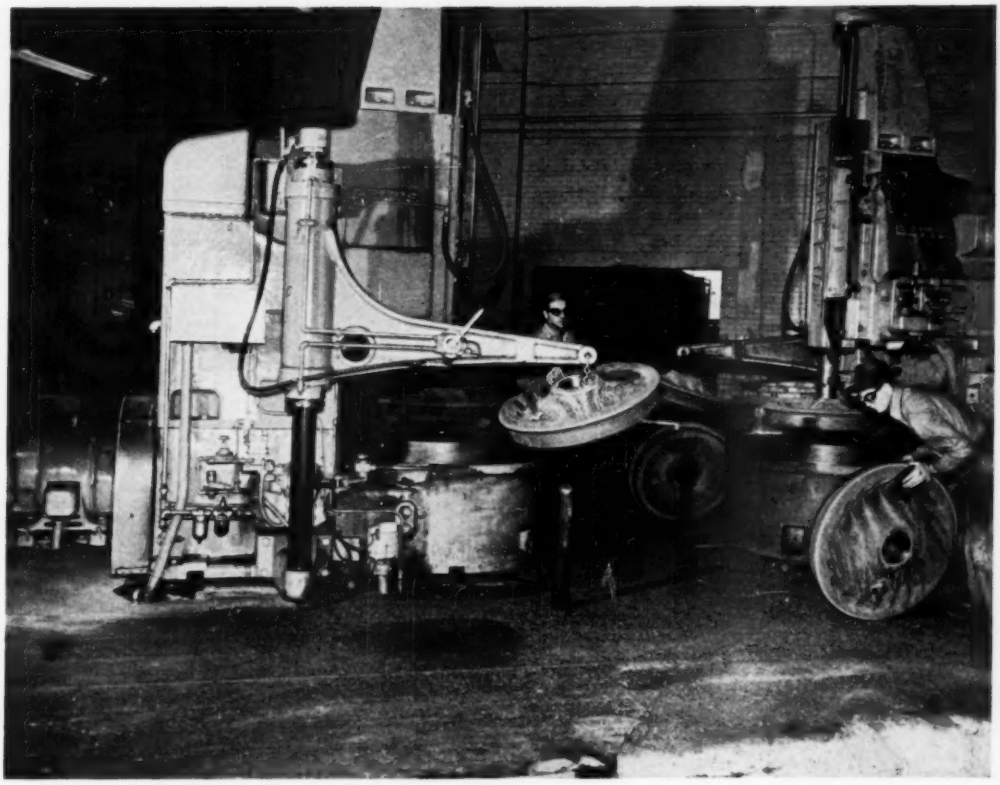
For example – the four compressors in the ACF plant are lubricated with Sinclair RUBILENE Medium. Proof of outstanding lubrication stamina is attested to by this service report: *"None of these compressors has required servicing of valves, rings, or bearings for over two years."*

Results speak volumes for this Sinclair Product. Why not investigate the advantages of RUBILENE Oils, available in *nine* viscosity grades? Contact your nearest Sinclair Representative or write Sinclair Refining Company, 600 Fifth Avenue, New York 20, N.Y.

SINCLAIR RUBILENES®

Bearing Service

...SAYS THE AMERICAN CAR AND FOUNDRY COMPANY

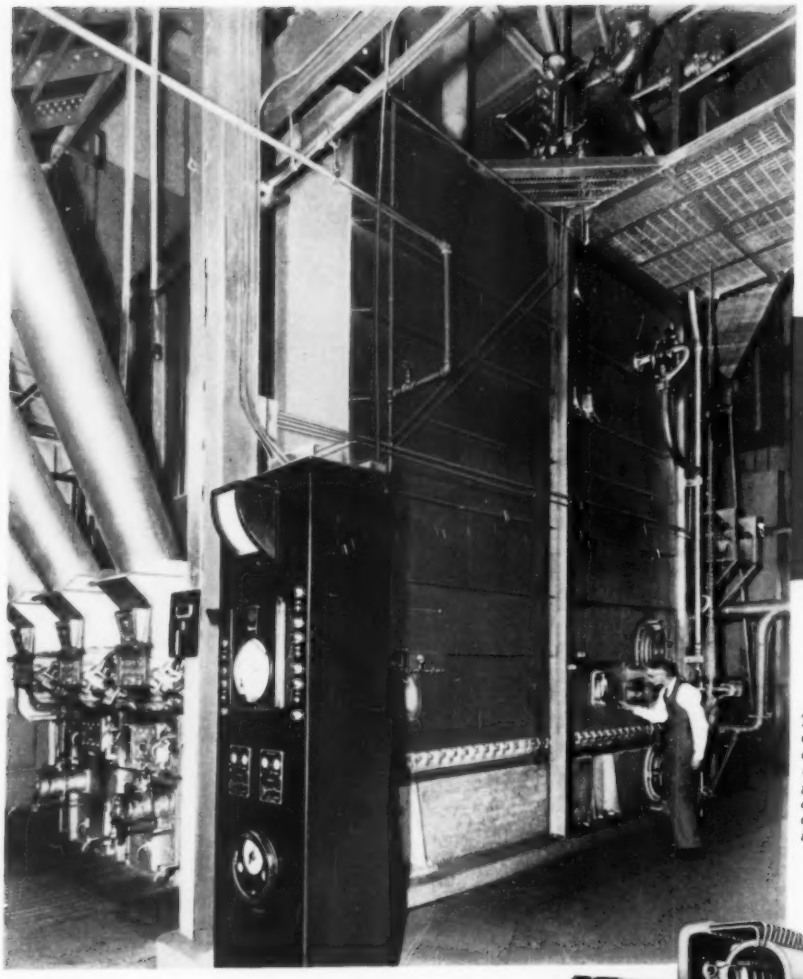


"Rubilene has given Trouble-Free Service."

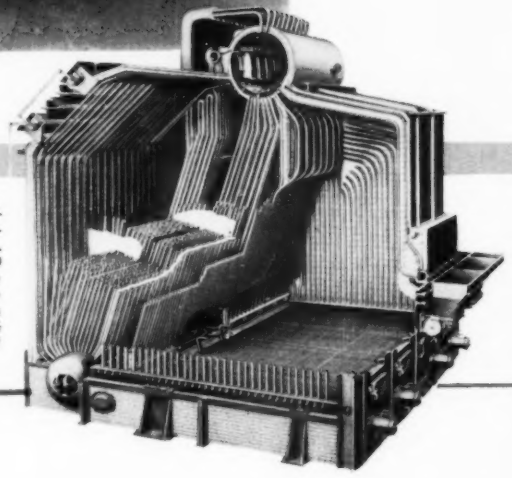
Further proof of RUBILENE quality is found in the operation of two Betts Heavy Duty Hydraulic Feed Car Wheel Bores. The American Car and Foundry Company says, "RUBILENE Oil Extra Light has given trouble-free service as the hydraulic fluid since these machines were put in service. No problem either, with chatter or sticking air hoists—RUBILENE Oil Medium in the air line lubricators does this job admirably."

for low maintenance costs

For more data circle 514 on Post Card



Tom Turner, Chief Engineer of the Buffalo plant of General Mills, Inc. inspects the company's new B&W Integral-Furnace Boiler Type FJ, after verifying metered records of fuel savings exceeding 15 per cent.



Cutaway view of typical B&W Integral-Furnace Boiler, Type FJ, with stoker firing. Also suited for gas and oil firing. Steam capacity range—30,000 to 70,000 lb per hr at pressures to 800 psi. Design and operating features of this unit are described and illustrated in Bulletin G-70, available from The Babcock & Wilcox Company, Boiler Division, 161 East 42nd Street, New York 17, N. Y.

GENERAL MILLS

CUTS FUEL BILL

more than 15 per cent

with B&W Integral-Furnace Boiler

When General Mills, Inc., recently placed in operation a B&W stoker-fired Integral-Furnace Boiler at its Buffalo, N. Y. plant, the company immediately realized fuel savings amounting to more than 15 per cent. The new boiler was installed with no heat traps such as air heaters or economizers, so that the fuel savings are due to better boiler performance alone. Smoke nuisance, long a problem at this General Mills plant, has been eliminated by the new unit . . . to the complete satisfaction of company engineers and local authorities.

The General Mills, Inc. consulting engineers made the plans, B&W men did the entire erection and B&W service engineers moved in to start up the boiler, turning over to General Mills a complete and efficient operating unit. Since that day, the B&W Integral-Furnace Boiler, producing 45,000 lb of steam an hr, has operated continuously, and is destined to give General Mills long service at low cost.

You Can Have These
COST SAVING FEATURES

of B&W Integral-Furnace Boilers for Steam Requirements from 2,800 to 350,000 Lb. Per Hr.

- Minimum floor space and headroom requirements
- High fuel economy
- Smokeless combustion
- Adaptable to all fuels and firing methods
- Economical fast steaming
- Water-cooled furnace
- Clean, dry steam at all ratings, even with high boiler water concentration
- Quick response to wide and heavy load swing demands
- Easy to inspect and clean
- High availability with least attention

BABCOCK & WILCOX

G-561

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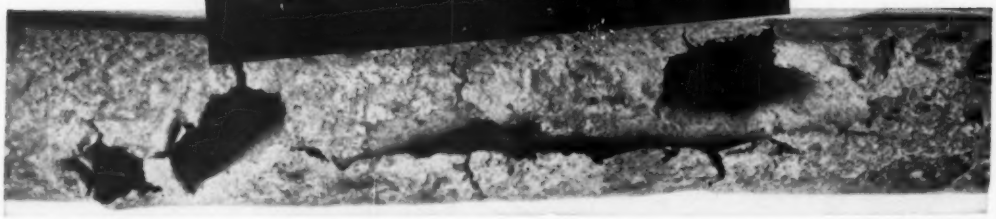
research at work!



Photograph of a section of a failed tube showing excessive thinning and pitting of the outer surface. Note also the circumferential cracks.

CORROSION STUDIES CAN INCREASE THE ECONOMY OF COPPER ALLOYS

Copper and its alloys are notable for their resistance to corrosion under a wide variety of conditions. There are industrial applications where copper or the appropriate copper alloy should give an indefinitely long life, but where failure because of corrosion may result by reason of unsuitable design of equipment or improper control of environment. Further, there are many situations in which no commercial metal or alloy will have an extended life, but in which copper or one of its alloys possesses a combination of physical and chemical properties which render it the best obtainable material, when all factors, including ultimate costs, are taken into consideration. Hence correct specification becomes of great importance. Recognition of this by industry is responsible for the fact that the Revere Research Department devotes so much time to studying the corrosive effects of fluids and gases, and to preventive measures.

Recently a large manufacturer, who produces condensers as well as other equipment, reported that arsenical Admiralty tubes in a steam-jet ejector were failing after five years. This length of service is not too bad, but nevertheless such tubes often last much longer. Could we make any suggestions?

Seven failed tubes were examined for type of corrosion, metal and scale analysis. The facts were: outer surfaces were badly pitted and grooved with holes completely through in some areas; the inside surfaces were relatively untouched; cracking was circumferential, progressing from the outside; outer scale was largely cupric carbonates and copper sulfide; inner scale was calcium carbonate, cuprous oxide and some iron oxide. Microscopic examination of the cracks showed they originated in corrosion pits on the outside, progressing inward across grain boundaries, rather than along them. The transgranular path of fracture, together with other characteristics of the microstructure, definitely established the fact that the failure was of the corrosion-fatigue type. The corroding pits on the outside created stress concentration points of weakness, from which the cracks originated. Eventually the localized stress exceeded the endurance limit of the metal and it cracked.

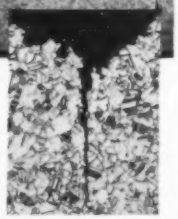
The conclusion was, therefore, that damage was from two sources—the first being excessive carbon dioxide and the other non-condensable gases in the steam, which caused the excessive pitting and thinning. It is not ununusual to have these and other corrodants present in damaging amounts in the air-ejector system, whereas they are not injurious elsewhere. The second cause of failure was excessive vibration somewhere in the unit which was responsible for the corrosion fatigue failure.

RECOMMENDATIONS. The copper-base tube alloy that generally possesses the greatest resistance to the non-condensable gases responsible for the corrosion of the Admiralty tubes is 5% aluminum bronze. Re-tubing with this was suggested. It was also recommended that steps be taken to effect a material reduction in tube vibration by placing a baffle in the steam inlet. In addition, it was pointed out that many operators find it good practice to discharge the after-condenser drain to the sewer instead of returning it to the system. By this means, the amount of carbon dioxide, ammonia and other gases in the system can be substantially decreased.

* * *

It is interesting to note that the Revere Research Department, located in Rome, N. Y., was able to determine these causes and suggest remedies without ever having seen the condenser. This is the result of modern equipment, and long experience in studying the problems of corrosion. If you have a problem regarding the corrosion of copper and copper alloys, or aluminum alloys, why not take it up with the nearest Revere office? Remember, corrosion that is too rapid wastes both your money and our national resources.

Here the circumferential cracking of the outer surface can be seen.



Photomicrograph of a section through a tube showing transgranular corrosion-fatigue crack originating from the base of a pit on the outer surface of the tube. Magnification 225X. All photographs taken by the Research Department of Revere.

REVERE

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* * *

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...to Balance Load Factor with Low Investment
...to Meet Present Needs and Future Expansion...

CLEAVER-BROOKS self-contained steam boilers are the answer to both present and future steam needs. You can install Cleaver-Brooks boilers in units to fit your present steam capacity requirements . . . keeping your investment at a minimum and your boiler efficiency at a maximum. Here's how it works . . .

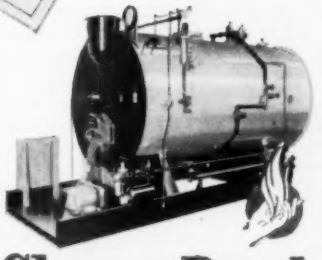
Your initial Cleaver-Brooks boiler installation is made in the size or capacity to fit your present steam load — this assures full use now at top efficiency and low capital investment.

As increased steam needs arise, additional Cleaver-Brooks boilers can be added to keep pace with your expanded requirements.

With this flexible program, you have the greatest return from your boiler investment — minimum original cost and lowest operating cost. Your boilers are always operating at maximum efficiency (80%) over the entire working range (30 to 100%).

Cleaver-Brooks self-contained boilers are ideal for multiple installations because of their compactness, low headroom requirements, fast installation, automatic operation, range of sizes. Available in standard models—15 to 500 hp.; 15 to 250 psi; gas, oil or combination gas and oil fired units.

Get all the story — write today for latest catalog.



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Builders of Equipment for the Generation and Utilization of Heat • Steam Boilers • Oil and Bitumen Tank-Car Heaters • Distillation Equipment • Oil and Gas-Fired Conversion Burners

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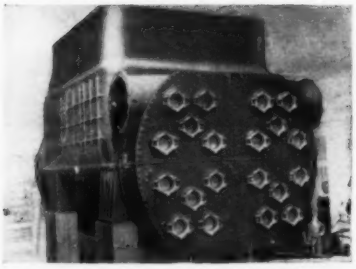
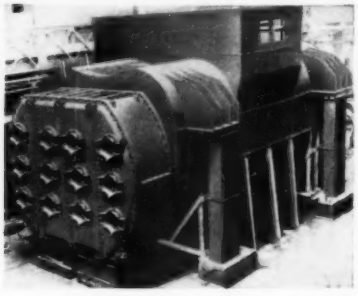
CON EDISON'S EAST RIVER ELECTRIC GENERATING STATION at 14th Street, New York City, will contain the new Worthington 125,000 sq-ft condenser. The shell, which is to be installed under 160,000-kw Unit No. 7, will contain nearly 105 miles of ¾" O.D. aluminum brass tubes and will require 138,000 gpm of East River water supplied by two 54 in. Worthington "Mixflo" vertical single suction volute circulating pumps.



WORTHINGTON CONDENSER installed in 1931 to serve 160,000-kw Unit No. 7, Hudson Avenue Station. Tube sheets were drilled for 110,000 sq ft with 101,000 sq ft installed.



ONE OF TWO 74,500 SQ-FT 2-PASS WORTHINGTON CONDENSERS serving 60,000-kw Units 14 and 15 at Waterside Station No. 1.

Con Edison once again installs "largest" condenser

On several occasions over the past fifty years, Worthington has been selected to build the "world's largest" surface condensers in single shell design.

In 1919, a 70,000 sq-ft condenser was installed under a 35,000-kw turbine-generator for a prominent utility company. This was the largest single shell surface condenser of its day.

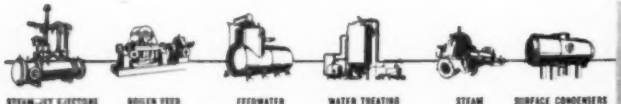
In 1931, Brooklyn Edison Company (now Consolidated Edison Company of New York, Inc.) installed, under 160,000-kw Unit No. 7 at the Hudson Avenue Station, the "world's largest" at that time, a 101,000 sq-ft single-pass Worthington condenser. This was followed, in 1949, by two 74,500 sq-ft condensers for Waterside Station No. 1.

Now, Worthington is again building for Con Edison the "world's largest" single-shell condenser ever ordered, 125,000 sq-ft, single-pass, for the 160,000-kw Unit No. 7 addition to East River Station.

Worthington, with over a century of experience in the manufacture of steam power equipment, is prepared to build efficient condensers in all sizes. Let us advise you, without obligation, on your new installation.

Write, stating requirements, to *Worthington Corporation, Steam Power Division, Harrison, New Jersey.*

Z.2.2



World's Broadest Line of Steam Power Plant Auxiliaries

WORTHINGTON

Condensers

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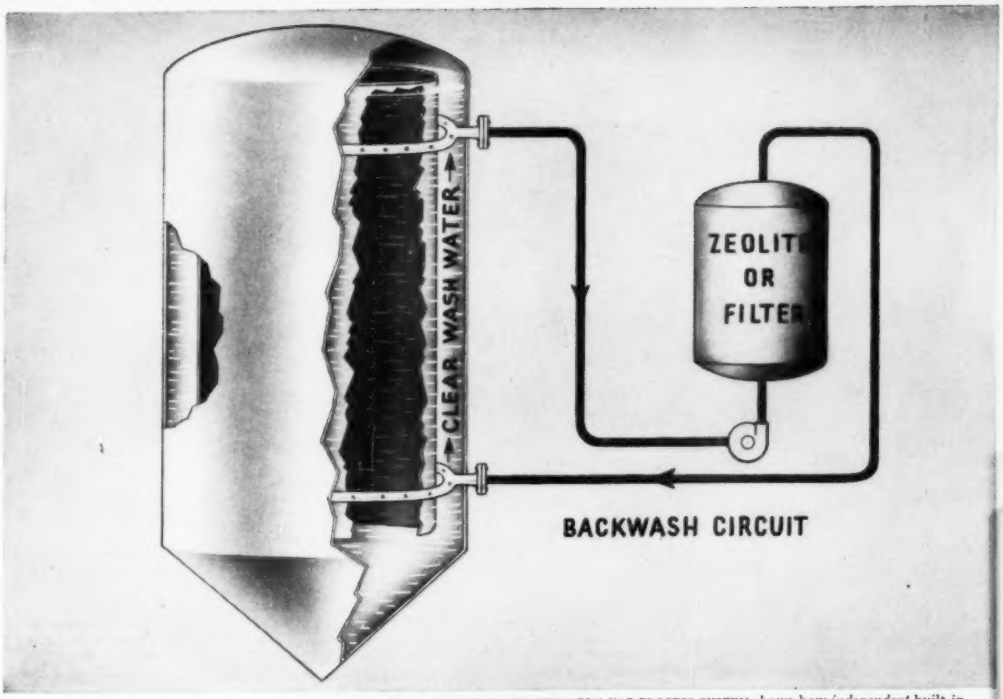


BACKWASH FLOW CIRCUIT IN WORTHINGTON HOT-PROCESS SYSTEM shows how *independent* built-in, annular wash-water compartment* provides clean, hot, chemically inert water for backwashing and reclaims it without affecting operating velocities in treating zone, or subjecting hot zeolite to temperature changes. Backwashing is accomplished by recirculation of the clarified wash water.
*Reg. U.S. Pat. Off. 2,263,398

You can't wash clean with dirty water!

How Worthington Hot-Process Water-treating systems backwash with CLEAN, hot, chemically inert water

When you're considering hot-process water-treating systems with hot zeolite, filters, or both, *don't overlook backwashing facilities.*

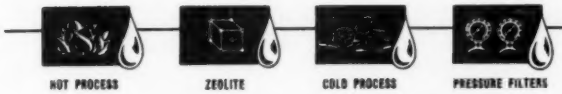
They must be well designed, or the system cannot give smooth, efficient, trouble-free performance. Worthington engineers recognized this fact when they designed their first hot-process system. Today, every Worthington standard Hot-Z or conventional system provides exclusive *independent* facilities for backwashing zeolite or filters with clean, hot, chemically inert water without disturbing the normal flow through the reaction bank.

Worthington water-treating specialists don't believe you can wash clean with dirty water.

This unique backwashing provision is just one of many Worthington patented features, but it alone will more than justify your selection of a Worthington system for hot-processing boiler feedwater in your plant.

If you have a problem, whether it involves filtration, precipitation, or zeolite treatment, Worthington specialists will be happy to study your water-treating problem and recommend the proper system. Just write, stating service conditions in detail, to Worthington Corporation, Water Treating Division, Harrison, N. J.

J.2.1



Worthington Makes More of the Equipment for ALL Types of Water Conditioning Systems

WORTHINGTON
Water Conditioning

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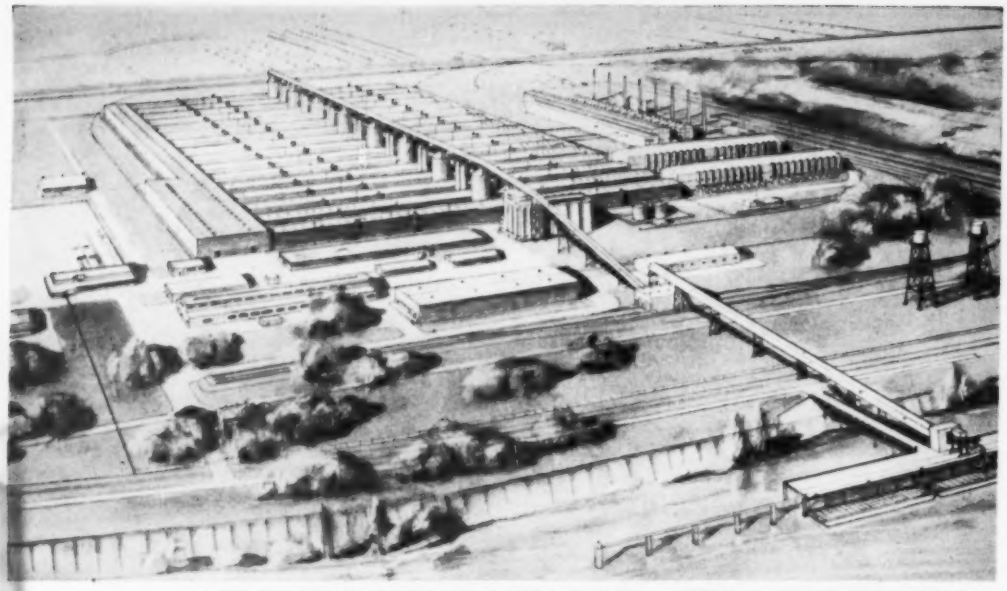


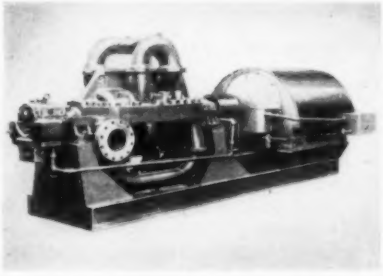
KAISER ALUMINUM AND CHEMICAL CORPORATION'S new 400,000,000 pound-a-year, $150,000,000 aluminum reduction plant at Chalmette, La., designed and built by Kaiser Engineers, is the largest plant of its kind in the U. S. The plant—where production began in December, 1951—uses 19 Worthington boiler-feed pumps and other Worthington equipment including thirty 9,300 square-foot condensers, and fifteen 250,000 pound-per-hour deaerators, 2 steam turbines and numerous circulating pumps.

Power plant at largest aluminum reduction plant to use Worthington pumps, condensers, deaerators

It takes plenty of electric power to produce 400,000,000 pounds of aluminum in a year. And that's what they're doing at the new Kaiser Aluminum plant at Chalmette, La.—largest aluminum reduction plant in the U. S.

Kaiser joins many other top companies in choosing Worthington boiler-feed pumps as well as other key equipment for their new plant. Such choices arise out of an insistence for equipment that's engineered for maximum performance.

Worthington engineering produces boiler-feed pumps of the most advanced design in the field, made from specially selected metals. Each pump is exactly *right* for the pressure and temperature with which it is to perform. Over 110 years of Worthington experience in building pumping equipment go into making this a certainty. Worthington Corporation, formerly Worthington Pump & Machinery Corporation, Centrifugal Pump Division, Harrison, New Jersey. C.2.4

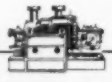


19 WORTHINGTON 250,000 LBS PER HR BOILER-FEED PUMPS at new Kaiser plant, handle feedwater at 257 F against a discharge pressure of 1,030 psig. Pumps are axial-balanced, volute type centrifugals. Two, similar to one illustrated, are driven by Worthington 450-hp steam turbines.

For Boiler Feed Service. Capacities to 1,500 GPM; Heads to 1,000 feet.

For Hotwell, Condensate, Chilled Water Service. Capacities to 1,400 GPM; Heads to 650 feet.

For Water Works, Circulation, Drainage, General Service. Capacities to 135,000 GPM; Heads to 400 feet.



For Boiler Feed Service. Capacities to 3,000 GPM; Heads to 7,000 feet.

WORTHINGTON

Centrifugal Pumps

The World's Broadest Line Assures You the Right Pump for Every Job

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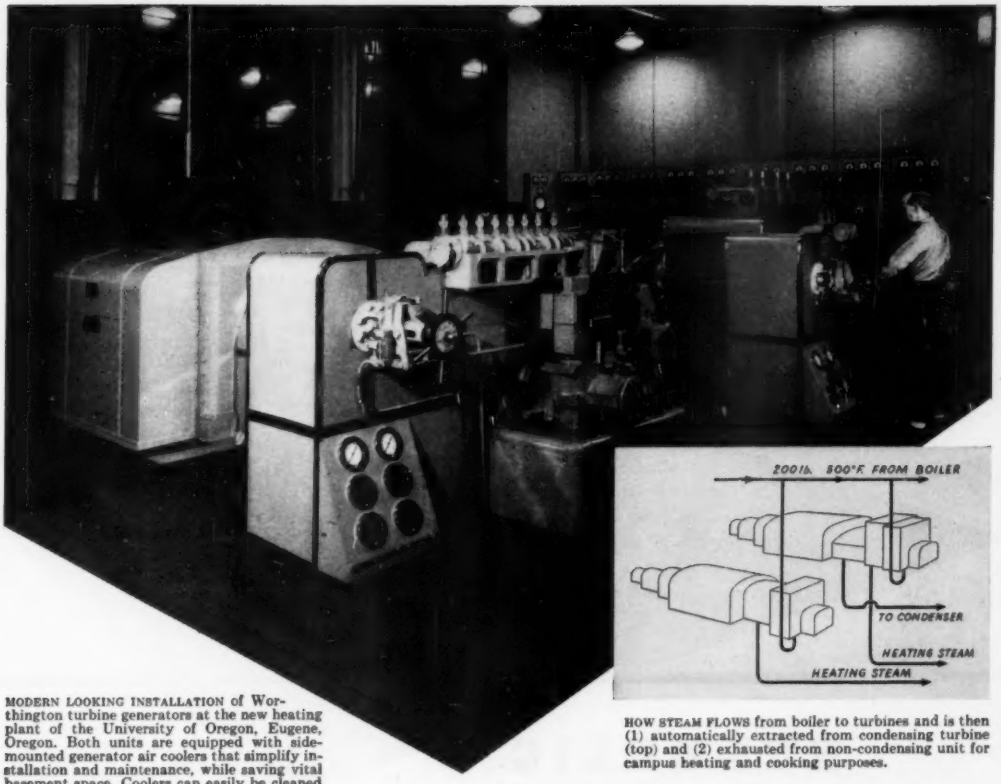

MODERN LOOKING INSTALLATION of Worthington turbine generators at the new heating plant of the University of Oregon, Eugene, Oregon. Both units are equipped with side-mounted generator air coolers that simplify installation and maintenance, while saving vital basement space. Coolers can easily be cleaned during turbine operation.

HOW STEAM FLOWS from boiler to turbines and is then (1) automatically extracted from condensing turbine (top) and (2) exhausted from non-condensing unit for campus heating and cooking purposes.

Worthington turbine generators at U. of Oregon designed for operating flexibility and appearance

When the University of Oregon built the new heating plant in 1951, the plans included installation of two turbine generators which would supply all the school's present and anticipated electrical and steam requirements.

But the university had another requirement—one not uncommon these days—that the installation be as clean and as modern looking as possible. One look at the above photograph and flow diagram shows that they got both in the Worthington turbine generators now in operation at the plant.

In the installation of Worthington turbine generators, the University of Oregon was assured of low-cost power and steam. It was also assured of the undivided responsibility that goes with turbine generators, designed, engineered, assembled and tested as complete units before shipment.

Sizes to 10,000 kw. Worthington Corporation, Steam Turbine Division, Wellsville, New York.

T-2-18

A GREAT TEAM IN STEAM

WORTHINGTON

Steam Turbine Generators

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You are cordially invited to visit Booth No. 6 to inspect the Republic Electronic TELEMASTER Control which will be on exhibit. Our engineers will be available to explain its many unusual features. The complete line of Republic instruments and controls will also be included in the exhibit.

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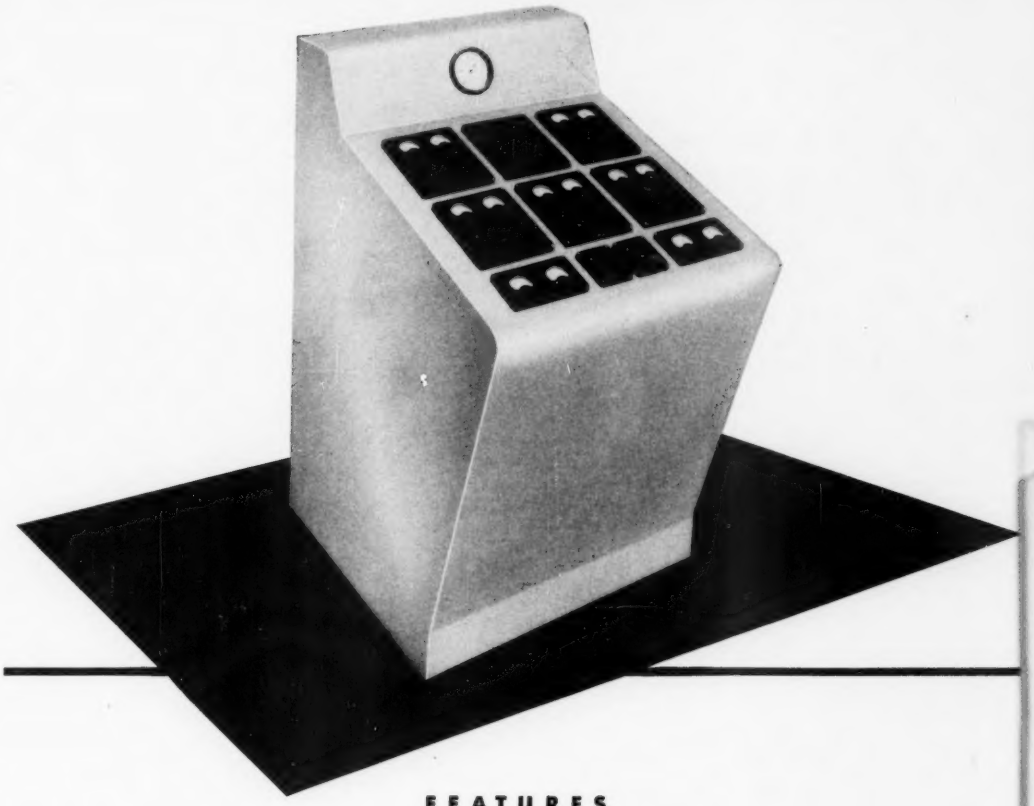
Electronic Master Control System

"TELEMASTER"

The Republic Electronic TELEMASTER Control represents a major advance in the field of automatic control. The TELEMASTER will remotely reproduce, quickly and accurately, a position or a force—perform arithmetical and algebraic calculations—and can be used for multiple operation. Essentially it performs the functions of a mechanical link through electrical and electronic means. It is applicable to all types of combustion and process control.

In plants where distances between operating units are great, the lags inherent in the compression effect of a pneumatic master system are appreciable. This effect is frequently sufficient to prevent realization of the full benefits of automatic control. The Republic Electronic TELEMASTER Control has a minimum inherent lag, independent of distance. This means that centralization of operations can be achieved without any sacrifice of control performance. *Full details sent upon request.*



FEATURES

NO DEAD SPOTS OR LAGS

The TELEMASTER operates on a null-balance principle with a constant check-back between the initial input and final output, with no intervening mechanisms to cause dead spots or lags. This balance type detection of any deviation in the desired operating conditions, produces a highly responsive and fast acting control system.

ELIMINATES PANEL PIPING

No control panel piping is necessary with the REPUBLIC TELEMASTER. Easily installed, multi-wire cables are the only connection between the TELEMASTER benchboard and the plant measuring and control elements. Results? Easier, faster and better appearing installation, increased flexibility, economy, and reduced maintenance.

GREATER APPLICATION FLEXIBILITY

Flexibility required for complete centralization of controls at a central focal point is a distinct feature of the TELEMASTER. The system may be operated under completely automatic, semi-automatic, or manual control from a central supervisory station.

PLUG-IN INTERCHANGEABLE PARTS

Due to simplicity, compactness and interchangeable component parts, the TELEMASTER provides a more flexible control system and a more condensed panel area than previously possible. All parts subject to replacement are mounted on compact plug-in units that are easily interchanged and replaced with spare parts.

REDUCED MAINTENANCE

Control room maintenance is sharply reduced. No moving parts or mechanisms are mounted on the control panels. Panel equipment is smaller and less cumbersome, no panel piping is used. Plug-in replacement parts may be installed in a matter of seconds. All components of the TELEMASTER are fully tested and proven for prolonged trouble free service.

REPUBLIC FLOW METERS CO.

2240 Diversey Parkway, Chicago 47, Illinois

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Sound Selling vs. Smart Talk

Today, essentially, all of the chemical companies have established technical service and sales-supporting technical work. One corporation has 25 laboratories devoted to this type of work supported by 29 field laboratories. The total investment by the industry in such facilities, must run well into the tens of millions of dollars, which is one measure of how importantly the industry regards the sales function.

It is now estimated that 70% of the average chemical company's sales staff is technically trained compared with probably less than 25% only 20 years ago and an insignificant percentage 30 years ago. This current mode of selling is epitomized in the slogan of one chemical manufacturer, namely, "Serving Industry through Practical Applied Science."

From an article: "Selling . . . Its Importance in the Chemical Industry," by J. Warren Kinsman, Vice-President, E. I. du Pont de Nemours & Co., Wilmington, Del., in Chemical Engineering Progress.

Nalco appreciates the use of its slogan, "Serving Industry through Practical Applied Science", as an example of the modern approach to chemical sales. 100% of Nalco's field service representatives are technically trained to help industry make full practical use of the chemicals and methods developed by the Nalco Laboratories: Water, Microbiological, Physical Chemistry, Organic Chemistry, Corrosion, Micrography, Metallographic, Experimental Boiler, Combustion, Oil Treatment, Paper, Ion Exchange, Weed Control, Production Control.

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THE *Nalco*®

SYSTEM . . . Serving Industry through Practical Applied Science

Helpful Bulletins

THE ANSWERS to many of your operating and maintenance problems are found in these new and recently revised catalogs and bulletins. Circle item numbers of all catalogs wanted on the postage-free card below, detach and mail

INSTRUMENTS AND CONTROLS

101 Evenly Graduated Meters — Catalog 2300, 28 pp, presents evenly graduated flow meters for measurement, recording, indication and integration of fluid flows. The characterised bell for square root extraction and electronic integrating mechanism are covered in detail. Models described include the electric meter utilising an induction bridge system for remote measurements, company's Electronik flow recorder-indicator featuring an electronically powered circuit, and the area type meter for the measurement of viscous flows. Brown Instruments Div., Minneapolis-Honeywell Regulator Co.

102 For Difficult Metering — A pneumatic flow meter for measuring widely fluctuating flows, dirty fluids and other difficult fluids is described in Bulletin 704. This flow meter can operate at static pressures up to 2000 psi and differential pressures 0.6 to 704 in. water, and reading instruments and dials may be remotely located from point of measurement. Republic Flow Meters Co.

103 Sight Glass Flow Indicators — Twelve-pp Bulletin 18-W, on company's line of flow indicators, shows how these mechanical devices indicate fluid flow and its direction in pipelines which can be directly observed through a sight glass and are suitable for service with liquid, gas, vapor, slurry or sludge sufficiently transparent to permit observation of indicating element. Flapper, ball and rotary type models are described and pictured, along with information on application and installation. Schutte and Koerting Co.

104 Pressure Transmitter — Bulletin 328 describes a pressure transmitter for use with pneumatically operated instruments for measuring pressure of liquids and gases where a positive seal is needed between gaging system and fluid measured. It can be used with practically any fluid. Methods of operation, models available and typical applications are presented. King Engineering Corp.

105 Pneumatic Controller — Catalog C-50, 20 pp, describes a pneumatic controller for rate of flow, differential pressure, liquid level, viscosity, pressure and temperature applications. This controller, the P-4 Pneumatrol, is for single or dual instrument case mounting and for point-of-measurement installation as well. Action and components of controller are described in detail. Fischer & Porter Co.

106 Electronic Controller — In addition to giving a brief resume of the Autronic principle, Bulletin A-702, 6 pp, also describes company's Autronic controller. Generously illustrated, the bulletin presents this control system as the first miniature all-electronic system for controlling pressure, temperature, flow and level. The Swartwout Co.

107 Pneumatic Valve Operator — This 8-pp bulletin explains operating principles and outstanding features of the Rotomotor positioning operator for throttling control service. Tells how this heavy duty, all-pneumatic operator is designed to combine safety and economy of air operation with the power of a gear driven screw stem. Conoflow Corp.

108 Multiple Burner Protection Systems — Bulletin 9003 contains data on combustion safeguard systems for industrial ovens, furnaces and other heat treating applications fired by multiple oil or gas burners. Describes system components, lists shut-off options available. Brown Instruments Div., Minneapolis-Honeywell Regulator Co.

109 For pH Control — A system for automatic recording and control of pH is described in Instrumentation Data Sheet 10.7-1, 4 pp. Discusses measuring system components, adjustments for operation, variations in recording and control systems for electric or pneumatic modes of control, and single or multi-point recording. Brown Instruments Div., Minneapolis-Honeywell Regulator Co.

VALVES, TRAPS AND PIPING ACCESSORIES

110 Gate Valves — This new 8-pp catalog section describes a new line of cast steel gate valves. Contains information on design details, material specifications, pressure and temperature ratings, and dimensions and weights. Features described include close fitting guide ribs which prevent wedge drag on seat faces, one-piece bonnets, ball-bearing yokes. Edward Valves, Inc.

111 Automatic Regulating Valves — Twelve-pp Bulletin 535 covers a line of steam pressure regulating valves and introduces three new types. Complete sizing tables included, as well as capacity tables, and a helpful section on selection. D'Este Div., Kaye & MacDonald, Inc.

112 Feeders and Rotary Valves — Eight-pp Bulletin P-4 gives engineering data on roll, vane-type, and enclosed type feeders, and rotary valves for dry pulverized and granular materials. Illustrated with photos, sketches and dimensional drawings, text covers construction and application. Includes list of materials handled by the feeders. Fuller Co.

113 Electrically Operated Valves — This bulletin provides data on manufacturer's solenoid valves available for pressures to 3000 psi. Adjustable timing on closing stroke is available to pressures of 300 psi, a feature designed to eliminate shock on supply lines. These valves are intended for hydraulic operations, oil, water, steam, air, gases and any media not harmful to bronze. The Atkomatic Valve Co.

114 When Vacuum Isn't — This informative brochure, "Vacuum Isn't Vacuum to a Steam Trap," discusses the following questions in relation to steam traps: What is vacuum? How does it affect trap operation? Does flash steam from trap destroy vacuum? What are common causes of leak of vacuum? Test is illus-

DECEMBER, 1952
Good until 1 month
POWER ENGINEERING

Please have the manufacturer send me without obligation information or bulletins indicated by the numbers circled below.

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City .....
Title .....
Plant .....
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City .....
Plant .....

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trated with diagrams, charts and examples. Armstrong Machine Works.

115 Liquid Filters — Twelve-pp illustrated Bulletin D-FL, describing liquid filters, contains specifications, engineering and performance data, photos and descriptions of recommended types of filter media, as well as a check list of filterable liquids. Includes a detachable data sheet with reverse side left blank for sketches of proposed installations. Dollinger Corp.

116 Insulated Pipe — Manufacturer's pre-sealed insulated pipe for underground and weather-exposed piping systems conveying hot or cold liquids or gases, is presented in this bulletin. Gives applications, special features, design, construction, fabrication data and specifications. Durant Insulated Pipe Co.

ELECTRICAL, LIGHTING

117 Automatic Voltage Stabilizers — Twelve-pp Bulletin GEA-5754 covers automatic voltage stabilizers ranging from 15 to 5000 va. Contains photos and diagrams of the equipment, explains operational principles and construction and gives complete specifications. Also describes causes and effects of voltage variations and lists typical applications for stabilizers. General Electric Co.

118 Mineral Insulated Wiring — This 20-pp on company's Safety system of mineral insulated, metallic sheathed wiring, contains a history and detailed explanation of the outstanding characteristics and applications of this new wiring system. Discusses its resistance to heat, moisture, and aging, non-inflammability, ruggedness, compactness, current carrying characteristics. Photos of recent installations are included, also step-by-step pictures showing termination procedures. General Cable Corp.

119 Dry Type Transformers — Control circuit transformers designed to provide better voltage regulation with low power factor circuits where momentary overload caused by high inrush currents is an important consideration are presented in 8-pp Bulletin T-5111. Construction details and advantages, specification charts and wiring diagrams included. Hevi Duty Electric Co.

120 Cable Boxes — Sixteen-pp Bulletin BA52 covers a comprehensive line of cable boxes for plain splicing, for solid inter-connecting, for sectionalizing with links or fuses, electric insulated cable circuits for system flexibility. Contains photos, dimensional drawings, ratings, and descriptive data. Includes ordering instructions. G & W Electric Specialty Co.

121 Rectifier Stacks — Bulletin GEA-5699A, describing basic characteristics and applications of copper-oxide rectifier stacks, is complete with charts, graphs and tables illustrating the characteristics, manufacturer, circuit design and use of these rectifiers. Gives ratings, advantages. General Electric Co.

122 Electrical Equipment for Chemical Processing — Divided into three sections — power generation, distribution and utilization — Form B-5656 illustrates and explains the function of electric equipment as varied as turbine-generators and bus duct. Apparatus is covered concisely, giving only standout characteristics and advantages of each to the chemical processing industry. Westinghouse Electric Co.

123 Industrial Lighting Standards — The 44-pp latest edition of the RLM Standard Specifications Book contains detailed specifications for 18 of the most commonly used incandescent and fluorescent industrial lighting units. Includes important revisions and clarifications of existing specifications, and new tables of typical coefficients of utilization and light distribution curves, as well as two new specifications for high-mounting units for high-bay industrial installations. RLM Standards Institute.

PUMPS AND COMPRESSORS

124 How to Pick a Pump — Twelve-pp Bulletin 52C6059J, titled, "Handy Guide to Selection of Centrifugal Pumps," covers general purpose, double suction, multi-stage, special purpose, marine and mixed and axial flow pumps. It also has a head-capacity table for single-stage double suction pumps. Special purpose pumps mentioned in this selection guide include solids handling, paper stock, sewage, rubber-lined process, coolant and circulating units. Allis-Chalmers Mfg. Co.

125 Rotary Pump Service Manual — The installation, operation and maintenance of rotary pumps are covered in 12-pp Service Manual 100-2. Subjects discussed include installing of foundation bolts, alignment, supporting vertical pumps, grouting, piping, suction lines, lot liquid pumps, rotation, packing, dismantling, reassembly, starting, operation and standing idle. Includes charts and sectional elevation drawings. Warren Steam Pump Co., Inc.

127 Frame Type Centrifugal Pumps — Designed for most ordinary pumping jobs requiring capacities to 500 gpm and heads to 135 ft, the centrifugal pumps described in Bulletin 52B6691A are built for V-belt drive, can be mounted in a variety of positions, and connected to any type of prime mover. Cross section diagrams of the three available types, showing cast iron frame included. Allis-Chalmers Mfg. Co.

128 Gas Engine-Driven Compressors — Bulletin 124 is a 50-pp, well-illustrated booklet on manufacturer's HMA Midget Angle compressor available in models of two, four, six and eight cylinders, 80 to 330 bhp. Stressing the flexibility, easy installation of this packaged compressor station, shows how it meets basic requirements for a semi-portable field compressor and discusses further advantages. Construction and design of component parts are described and pictured in detail. Clark Bros. Co., Inc.

129 Heavy-Duty Compressors — Heavy duty package types of company's Feather Valve compressors from 75

(Continued on page 116)

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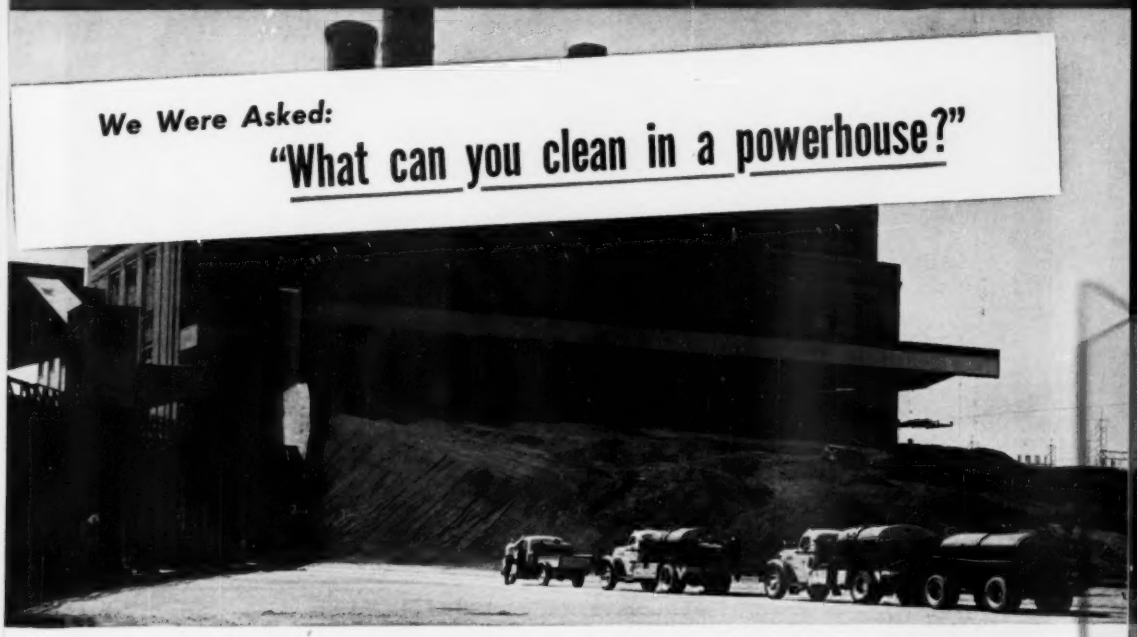
DOWELL SERVICE

CHEMISTRY APPLIED TO MAINTENANCE CLEANING PROBLEMS



We Were Asked:

"What can you clean in a powerhouse?"

Here's Our Answer...*Proved by recent Dowell Jobs!*

There are many places in every industrial plant where Dowell Service can cut operating costs and *increase production time*. Wherever deposits on the surfaces of condensers, boilers, heat exchangers, water lines and other equipment are reducing capacity, Dowell Service can show money-saving results.

Dowell furnishes trained personnel and all necessary special equipment. Dowell engineers apply liquid solvents according to the technique demanded by the job: for example, by filling, spraying, jetting, cascading or vaporizing. The solvents are designed to remove deposits *quickly*, efficiently and economically. Dismantling is unnecessary and downtime is kept to a minimum. Often equipment can be cleaned while it is in operation.

Experienced Dowell engineers will be glad to consult with you on your particular problems. Call the nearest Dowell office today!

BOILER: A boiler was making only 12,000 lbs. of steam per ton of coal. After Dowell Service, the output increased to 18,000 lbs. of steam per ton of coal.

ECONOMIZER: A return-bend, integral economizer was cleaned by Dowell Service in 8 hours with no dismantling.

SUPER HEATER: Several tubes had blown out on a pendant type, non-drainable superheater because of heavy deposits. In just two working days Dowell Service did a complete job of removing these troublesome deposits.

TURBO SURFACE CONDENSER: An 800 KW Turbo Condenser was cleaned by Dowell. Result: The drop in steam rate demand represented an estimated yearly savings of $3600 in coal.

EVAPORATOR: Before cleaning, an evaporator operated at 24 lbs. per square inch steam and 11 inches of vacuum. After Dowell Service, it operated at 4 psi. steam and 13" vacuum.

HEAT EXCHANGER: Pressure drop on a heat exchanger was 52 lbs. with 150 gallons per minute flow. After Dowell Service, pressure drop was 22 lbs. with 200 g.p.m. flow.

BOILER FEED LINES: Before cleaning, it was necessary to use three 100 horsepower pumps to force water through clogged feedlines to the boiler house. Following Dowell Service, only one pump was required.

PUMP: Two high pressure feedwater pumps were nearly clogged with deposits. Dowell Service cleaned them along with the rest of the feedwater system.

TURBINE: Deposits on the rotor and stator of a turbine were removed quickly and efficiently by Dowell Service *in three hours.*

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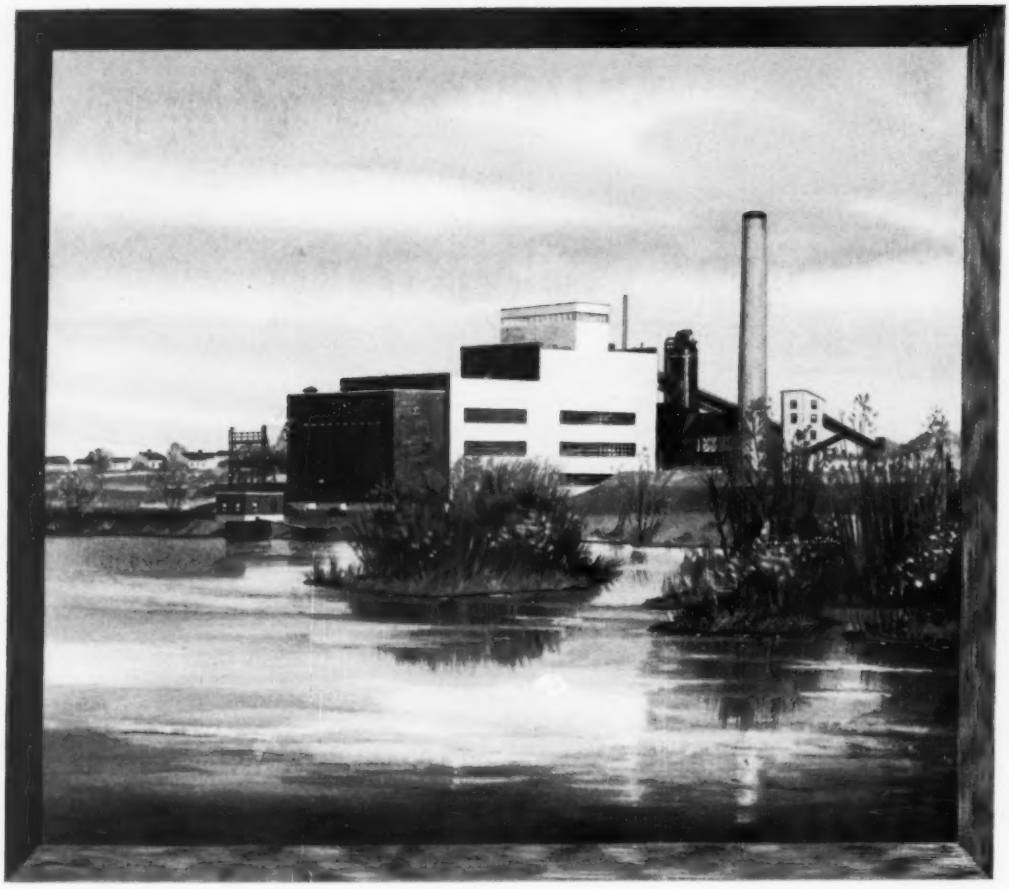

SABROOKE STATION, ROCKFORD, ILLINOIS . . .

The first unit of Central Illinois Electric and Gas Co.'s Sabrooke steam power plant provided 20,000 kilowatts of electricity for the fast-growing community of Rockford, Illinois. It was completed in 1949.

A unit of 30,000 kilowatts was added to the plant this year. Another installation of 30,000 kilowatts is scheduled to go "on the line" in 1954 and facilities are provided for the future installation of two additional generating units.

Stone & Webster Engineering Corporation was retained to design and construct the Sabrooke Station.

STONE & WEBSTER ENGINEERING CORPORATION

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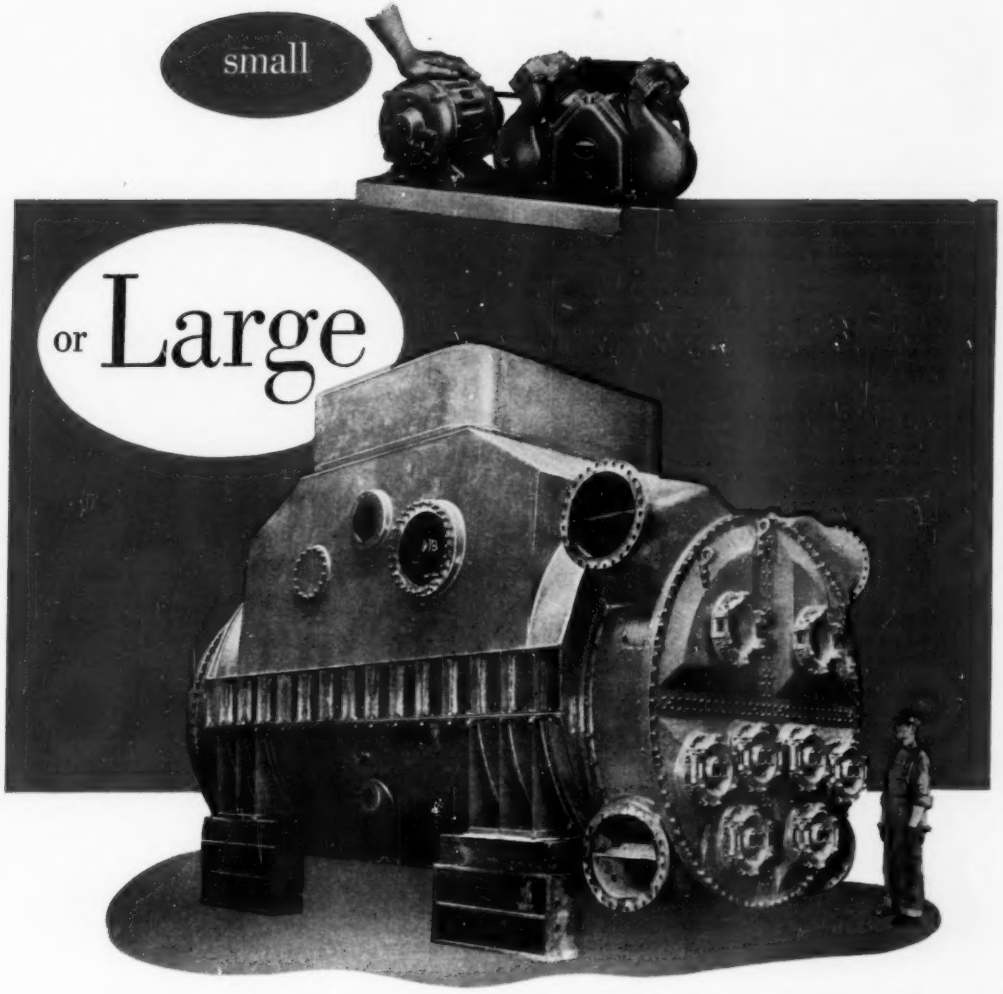

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Equipment News

SUMMARIZED HERE are new products and improved ones . . . recent developments of leading manufacturers who will gladly supply further information at no cost. You may use the no-obligation, postage-free cards on pages 38 and 115 for your request. Just circle the numbers of the items you'd like to know more about

1—HIGH VACUUM DIODES

For industrial use in high-voltage rectifier applications

These new rectifier tubes are available in two types. The Type 6102 is designed for use in rectifier applications involving peak inverse voltages up to 40 kv. The maximum average current is 150 ma and peak current is 900 ma. It is intended for oil-immersed operation, and is only $2\frac{13}{16}$ in. long and $2\frac{3}{16}$ in. dia.

The Type 6103 is designed for use in rectifier applications involving peak inverse voltages up to 20 kv. The maximum average current is 150 ma and peak current is 900 ma. This tube has an integral radiator for forced-air cooling. It is $2\frac{15}{16}$ in. long, $2\frac{3}{16}$ in. dia. The compact design of these new tubes is said to be of particular value where space and weight savings are of importance. Electronic Tube Div., Westinghouse Electric Corp.

2—PRESSURE TRANSMITTER

Is for use in automatic electronic control systems

A new differential pressure primary element transmitter, the Type D2T is used in conjunction with manufacturer's Autronic Control System and covers a differential pressure range of 0 to 20 in. to 0 to 200 in. water at static pressures

to 1500 psig. Installed at the point of measurement, the unit transmits an electric signal which is directly proportional to the variable being measured.

A feature of this differential pressure transmitter is an anti-thrust pressure seal which transmits motion of the sensing diaphragm to the signal-generating differential transformer, and acts as a seal against high static pressures. The unit incorporates a spring for zero adjustment, a linkage-ratio adjustment for coarse span and an electrical adjustment for fine span which does not affect the zero adjustment. Extremely compact, the unit is only 13 in. long and weighs 26 lb. The Swartwout Co.

3—TEST UNIT

Is designed for use in higher current testing applications

Principal uses announced for the new Model 1005 include testing and calibrating of oil circuit reclosers, CSP transformer breakers, sectionalizers, circuit breakers, motor overload relays, current transformers, fuse links and overcurrent relays. Manufacturer says the unit may also be used for drying out damp electrical windings and making "heat runs" on wires and connectors, also switches and sockets.

The output of the Model 1005 is adjustable in stepless increments from 0 to 1000 amp in eight ranges, each rated at 2.5 kva based on a 4-hr duty cycle. Terminal voltages are adjustable from 0 to 115 per cent of the following values: 200, 100, 75, 50, 25, 10, 5 and 2.5 v. Additional information is provided in Bulletin 1005-111. Multi-Amp Corp.

4—VARIABLE SPEED MOTOR

Is lightweight fhp unit equipped with flexible shaft control

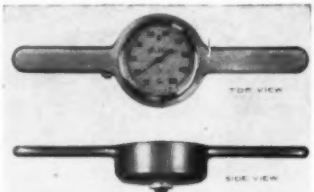
The remote control feature of the Varidrive Type 5 VA includes a control handwheel with indicator dial and a 5-ft flexible cable so that the machine operator can control the Varidrive's speed distant from the motor. An advantage cited for this control arrangement is that the dial indicator is a part of the control, making it unnecessary to go to the motor to see what speed is being "revved up." Connecting cable longer than 5 ft can be used, if necessary.

The Type 5 VA Varidrive is available in $\frac{1}{4}$, $\frac{1}{3}$, $\frac{1}{2}$ and $\frac{3}{4}$ hp and in a speed ratio up to 10 to 1 over a range of 4 to 10,000 rpm. The entire unit is a one-package motor with the variable speed mechanism enclosed. Literature on it is offered. U. S. Electrical Motors Inc.

5—HANDLE THERMOMETER

Lets operator hold it in place without burning his hands

In applications where thermometers can't be screwed in position but must be held in the hand, the ambient or transmitted heat may be too hot for the operator. With this instrument a comfortable hand grip is provided on both sides of the dial, it is said, so it can be plunged directly into hot mixtures and



chemicals without burning the operator. The handle is curved to fit the palm of the hand and also acts as extra protection for the thermometer since it encases the edge and underneath portion.

The thermometer is available in dial diameters of $4\frac{1}{4}$, $2\frac{13}{16}$ or $2\frac{1}{4}$ in. and in stem lengths up to 72 in. The thermometer proper is of acid resistant stainless steel and the handle (which can be unscrewed) is of cast aluminum with hammered enamel finish. Ranges offered cover popular industrial requirements in either Fahrenheit or Centigrade scales. W. C. Dillon & Co., Inc.

6—REACTOR

Designed for safely measuring d-c current as high as 120,000 amp

Made in five standard models of from 1000 to 10,000 amp, this new reactor is available up to 120,000 amp on special order; it is designed for users of large amounts of d-c power. Main feature of

the new device is that it isolates the current leads from the current being measured. Instrument leads are energized at low a-c voltage, usually 120 v, 60 cycles, reducing shock hazard at the control panel.

Due to electrical isolation between primary bus and secondary wiring, the main circuit is not affected by any faults occurring in the control wiring, say company engineers, and the argument for using high voltage cable in the control circuits is removed, with an economic saving in some cases. Leads to the instrument need not be calibrated, can be any reasonable length, and can be cut to size at time of installation.

Further advantages are seen in that the new device slips in place over the d-c bus and doesn't require that bus be broken or bolted connections be made at point of measurement and that the reactor uses only a small amount of power from an a-c source. Special Products Section, General Electric Co.

7—RECLAMATION PROCESS

Reclaims diamonds from all types of diamond containing waste

Recently announced is an electro-chemical process developed to reclaim diamonds from used or broken diamond impregnated grinding wheels, saws, drill bits, tools, sludge or swarf from grinding operations, lapping cloths and other materials. Details on the process, as well as on analysis of sludge or swarf, are available. Diamond Dust Co.

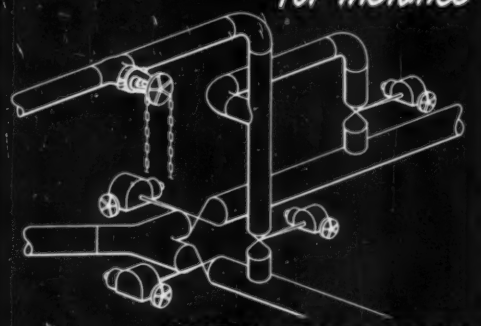
8—SELF-FORMING PACKING

Is designed to speed the job, cut costs and inventory

Described as self-lubricating and leak proof, Steamfitters' Special Packing comes in handy rope style which forms itself into a seal the size and shape of the stuffing box or fitting into which it is placed. Thus, only one size is made or needed. The packing is reported to be an excellent choice for installations in reciprocating boiler feed pumps, centrifugal oil pumps and valves, against oil,

Can You Rate Your Valves This Well?...

on Main Steam Service for instance



THE INSTALLATION

Crane Pressure-Seal Gate Valve on 8-inch main steam lead to house turbine. Steam conditions: 850 psi at 900 Deg. F. Southwark Station, Philadelphia Electric Co.

VALVE SERVICE RATINGS

MAINTENANCE COST:	None to date
FEATURES:	Highly practical Pressure-Seal design
SUITABILITY:	Eliminates bonnet joint leakage
SERVICE LIFE:	Now more than 4 yrs.
PRICE:	In line for this modern design
AVAILABILITY:	Regular item in Crane line

THE HISTORY

This valve was installed on a trial basis in the station's last extension program. In service now more than 4 years, this 900-Pound Crane Pressure-Seal Bonnet Gate Valve has completely eliminated any need of bonnet joint maintenance. Under constant high pressure/high temperature conditions, it remains perfectly tight at bonnet and stem; needs no costly attention.

Never, says the customer, does this Crane valve stick at the disc, even though operated infrequently. Its operation is as smooth and positive today as when first installed. As a result of this performance, the customer is continuing to specify Pressure-Seal type valves.

THE VALVE

Universally recognized for simplified development of the modern pressure-seal bonnet principle, Crane Pressure-Seal Gate Valves combine many added refinements. For example, their highly compact, weight-saving design reduces erection costs; streamline body contouring saves insulating labor and material. See your Crane Catalog or Crane Representative for complete details on these valves—in gate, globe, angle, and stop-check patterns; in 600, 900, and 1500-Pound pressure classes.

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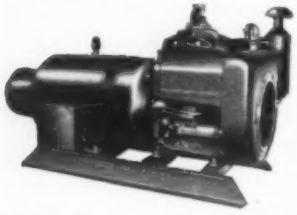
gasoline, many solvents, mild acids and caustics, and against steam, air hot or cold water. It comes in ½- and 2½-lb spools. Packing Div., Flexrock Co.

9—ELECTRIC PLANT

Is designed primarily to be used for emergency standby service

This ultra-modern electric generating plant is suggested for industrial plants, institutions and commercial buildings and is available with electric starting or with controls which automatically start



the plant the instant regular power fails. An important feature is its 4-cylinder air-cooled gasoline engine, said to require minimum maintenance. And its modern design with close coupled engine and generator, make it highly compact.

Claimed to provide an ideal combination of low initial cost and minimum operating expense, the unit can be furnished for single phase or three-phase service. Bulletin DHE-1 gives details. Universal Motor Co.

10—D-C POWER SUPPLY

For bench or wall mounting at individual work stations

These selenium rectifier power supplies are currently available in a 500-w unit and 300-w unit, both operating from a 115-v 60 cycle line and furnishing from 90 to 135 v of filtered d-c output, the voltage of which may be varied in approximately equal steps by a 5-position tap switch. Output ripple is said to be less than 5 per cent at full load. Both units are rated for continuous duty at full load and have overload protection built into the circuit.

These power supplies feature light weight, compactness and easy installation, company points out, the 300-w unit weighing only 6 lb, and the 500-w size, 8 lb. Besides their applications on assembly lines, the units are suggested for test and inspection stations and similar uses. They can be used to furnish d-c power for small d-c motors, relays, controls. Rapid Electric Co.

Want more details on these new products? Just circle the item numbers on the handy new-type post cards on pages 38 and 115

12—RECTIFIER UNIT

Is designed to provide exact low voltage regulation at low cost

A new type of a-c to d-c regulated rectifier is offered in the MagniVolt, which is announced as combining ruggedness and close regulation of low voltage in a dependable, low cost unit. Regulation is better than 1 per cent from no load to full load with ± 10 per cent a-c line variation, says manufacturer; response is faster than 0.2 sec, even under extreme contrast of load conditions, and RMS ripple is less than 1 per cent.

The MagniVolt is designed to operate on 115 v, single-phase 60 cycle current, and is built in standard models ranging from 1.2 to 28 v and from 2.5 to 30 amp. Designers of the new units credit their ruggedness to the magnetic amplifier incorporated which contains no moving parts and is said to require virtually no maintenance. The MagniVolt is also said to be insensitive to temperature changes, and because of its compact design to be applicable where space and weight are at a premium. Standard equipment includes a-c input, switch, fuse and pilot light as well as input and output posts. Inet, Inc.

13—ELECTRIC GENERATOR

Is 400-cycle type, featuring permanent magnet construction

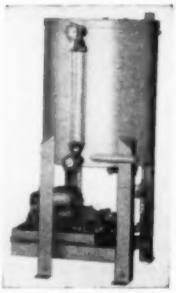
Among advantages credited to the permanent magnet construction of the improved Nobrush Electric Generator are immunity to damage by moisture, overload or short-circuit; durability and long life; reduction in size and weight; greatly reduced maintenance and elimination of radio interference. Units are furnished for belt drive or for mounting on driving motor or engine. Complete motor-generator or engine generator sets are available. The generator is suggested for portable power units, for operation of high frequency portable power tools and other applications. Outputs range from 250 va to 25 kva. The Georator Corp.

11—CHEMICAL FEED SYSTEM

Is compact "packaged" unit, supplied complete with tank, pump and piping for suction line

This unit consists of a 50-to-500 gal carbon steel chemical solution tank mounted over a controlled volume pump. Piping is supplied for the suction line, complete with valves and sight gage for reading liquid level. Accessory equipment, including agitators, dissolving baskets, low-level alarm panel, electrodes and relays, can be supplied.

Pumps are available in either Simplex or Duplex models, air-powered or motor-driven. They are manufactured in 10 types of metal, all designed for specific chemical services. Pump capacities range up to 300 gph and operate against pressures as high as 5000 psi. Milton Roy Co.



14—VERSATILE PLASTIC PIPE

Lightweight, will be produced in flexible as well as semi-rigid types

Manufacturer of this piping announces that the flexible pipe will be made in three types: non-toxic, industrial and suction, all of polyethylene. The non-toxic type will come in sizes ½ to 6 in., with sizes up to 3 in. available in coiled form. Its advantages are extreme light weight, flexibility, smooth interior for greater flow and resistance to rot, rust and electrolytic action. Company says it can be used for conveying liquids for human or animal consumption.

Having same characteristics as the non-toxic type, the industrial type is suggested for removal of corrosive liquids and for conveying of acids, alkalis, soaps, bleaching agents. The suction type (in sizes 2 through 6 in.) is for higher pressures in larger sizes.

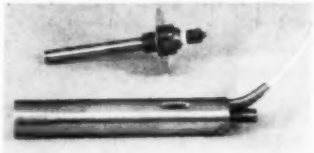
The semi-rigid plastic pipe, illustrated,

is made of butyrate and available in ½- through 6-in. sizes in 20-ft lengths with one coupling cemented. This type is described as flexible enough to follow ditching contours but having sufficient impact strength to eliminate special care in back filling. It is expected to find its best applications in the petroleum industry, but resistance to rot and rust, chemical and electrolytic action is said to make it acceptable for chemical piping, gas service entrance lines and food processing applications. A detailed booklet is available. Plastic Products Div., Triangle Conduit & Cable Co.

15—MIDGET THERMOSTAT

Is used for control and overheat detection where space is scarce

A redesigned midget Thermoswitch, whose heat-sensitive shell has an outside diameter of only ¼ in., is offered for applications in which precision temperature control or overheat detection must



be provided in solids, liquids or gases where space is at a premium. The midget thermostat is adjusted and sealed at factory to any temperature set-point in the range from −50 to 450 F, company states, and has an inherent sensitivity of 0.1 F. It is rated at 1 amp at 48 v a-c, or 32 v d-c. In the photo it is compared with one of company's standard cartridge thermostats of ⅝ in. shell diameter.

The midget unit shown, an inverse compression type in which contacts close with temperature rise, has a hex head, 1¼ in. removable nameplate, $1\frac{5}{64}$ pipe thread and $1\frac{29}{32}$ in. long stainless steel shell (over-all length is $3\frac{5}{32}$ in.). This thermostat is also

3 ERIE CITY "VC-C"
STEAM GENERATORS,
27,000 LBS. PER HOUR EACH,
FIRED BY OIL AND GAS IN A
WESTERN STATE CAPITAL BUILDING
ERIE CITY IRON WORKS

the Erie City "VC"

A 2-DRUM Steam Generator with complete furnace cooling

A 50 year experience with 2-drum boilers is reflected in this modern design. Today's ERIE CITY "VC" incorporates scores of design, manufacturing and installation improvements. The Erie City "VC", as described in our latest catalog, offers high capacity in a compact design which saves space — lowers installation and maintenance costs and assures good operating characteristics with a wide choice of fuels and firing methods. New Catalog VC-3 describes the Erie City modern 2-drum Steam Generator in detail.

You can depend on Erie City for sound engineering

ERIE CITY
112 Years in Steam Generation

ERIE CITY IRON WORKS • *Erie, Pa.*

STEAM GENERATORS • SUPERHEATERS • ECONOMIZERS • AIR PREHEATERS
UNDERFEED AND SPREADER STOKERS • PULVERIZERS

For more data circle 528 on Post Card

available with a straight thread. Although its shell volume is only ½ that of company's standard units, the midget thermostat is said to retain such operating characteristics as fast reaction time and high resistance to mechanical vibration and shock. Fenwal Inc.

16—SOLDERLESS TERMINAL

Is especially adapted for intricate control panel wiring jobs

In control panel wiring, due to close quarters, the outer plastic covering of a pre-insulated terminal may occasionally be pierced accidentally due to faulty insulation. The reinforced Ampli-Bond Terminal is designed so that no underlying conducting surface will be exposed even if the insulating sheath is pierced. This is accomplished by an insulated metal ring near the base of the insulation support sleeve. Company says this ring gives necessary support to combat vibration and sharp bending, but does not communicate with the electrical connection farther up the barrel. Terminals are now available in the 12–10 and 16–14 HD sizes, and smaller sizes are planned. All are color coded for easy indentification. Aircraft-Marine Products, Inc.

17—INSULATED ANCHOR

For underground piping, is designed to reduce heat loss

For use in underground insulated pipe systems conveying hot or cold liquids or gases, this anchor is so constructed that contact is eliminated between anchor plate and pipe. The plate is insulated from the pipeline both thermally and electrically by a non-compressible block of Transite sheet material. This serves to minimize heat loss at anchorage points and to prevent pipeline corrosion by electrolytic action. Durant Insulated Pipe Co.

18—HIGH PRESSURE BLOWER

Is designed for quickly removing fumes and bad odors

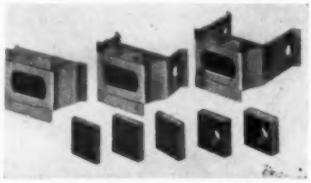
This blower for the removal of fumes, smoke, dust, sawdust and obnoxious odors is all aluminum and designed to

move up to 450 cfm. On the standard unit, made with a 5½-in. inlet and 3½-in. outlet, power is supplied by an enclosed ⅛ hp, 115 v, single-phase a-c 3450 rpm motor. Larger sizes with different speeds and current characteristics can be obtained, manufacturer states. Standard Electric Mfg. Co., Inc.

19—ADJUSTABLE INSERT

For use in concrete, saves both installation time and labor

This insert is announced as time-saving because it doesn't require "fishing" to get the bolt started in the nut after the nut is placed in the insert. The combination of the elongated hole in the face of



the insert and off-set hole in the nut makes it possible to put the nut on the bolt before placing in the insert, and then to adjust it as desired.

Other advantages claimed for these inserts include the ability to support a load of 1500 to 2400 lb, V-shaped notches in face and two center grooves on the side to simplify alignment of insert on forms, and four small holes in the insert to permit placing it on dowel pins or reinforcing rods. Inserts are made of heavy gage steel, can be obtained for bolt sizes from ¼ to ¾ in. Super-Grip Anchor Bolt Co., Inc.

20—BALANCING MACHINE

Is portable electronic unit designed for measuring vibration

The Model 652 Vibratron is described as a rugged and easy-to-operate machine for the analysis, evaluation and correction of vibration. It is designed to measure, without computation, the amplitude and frequency of the vibration and, by means of a stroboscopic light, discover the source. It consists essentially of a vibration pick-up, a multi-channel electronic circuit, and a stroboscopic lamp.

The Model 652 Vibratron is a maintenance and production, as well as research and inspection machine. As maintenance equipment it can be used to discover and correct unbalance in equipment to prevent loss of accuracy and discover and correct sources of wear to help prevent breakdowns and repairs. It can be used to synchronize machine speeds, and as a detection device to eliminate undesirable vibration from inside or remote sources. A folder on this balancing machine is available. International Research and Development Corp.

21—DRY-TYPE TRANSFORMER

For distribution service on secondary circuits up to 600 v

The Type E is a completely enclosed distribution transformer for secondary circuits rated 600 v and below; it supersedes company's AJR line of dry-type transformers. In addition to the 3-, 5- and 10-kva sizes of the former line, the new Type E will also be built in 15-, 25-, 37½- and 50-kva ratings. The three smaller sizes are for indoor or outdoor service and wall mounting. Those of the higher ratings, also for indoor or outdoor service, are designed for floor or platform mounting although the 15- and 25-kva units may be wall mounted.

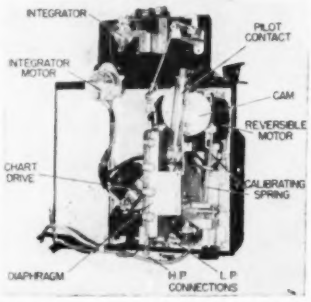
The new transformer utilizes Hypersil cores and Class H silicone insulation and operates at 120 C rise. Both high- and low-voltage leads are brought to Micarta laminated plastic terminal boards at the bottom of the case. Manufacturer points out that since the temperature of the terminal compartment is less than 30 C, standard insulated cables can be used for wiring through conduit. Westinghouse Electric Corp.

22—FLOW METER

For measuring air flow or gas flow or recording ratio of air flow

The Diaflow Meter is a low differential flow meter for measuring air flow, gas flow, or recording the ratio of air flow to gas flow. Described as especially adaptable for industrial furnaces and sewage disposal plants, it is used as a guide in achieving product, process and cost control. Utilizing the pilot method of operation in which no load is placed on the measuring element, this meter is said to possess high accuracy with negligible friction. Since it uses a dry diaphragm type measuring element, no water, oil or mercury are required and leveling is eliminated.

Unit construction, whereby parts can



be removed separately or as a whole without affecting calibration, is used throughout the Diaflow. The measuring element is company's differential type diaphragm unit which will accommodate static pressures to 10 lb and differential pressures to 20 in. water. To facilitate reading flow, a cam is incorporated to change the square-root relationship between differential pressure and flow to an easily-read equal-increment flow record. The Hays Corp.

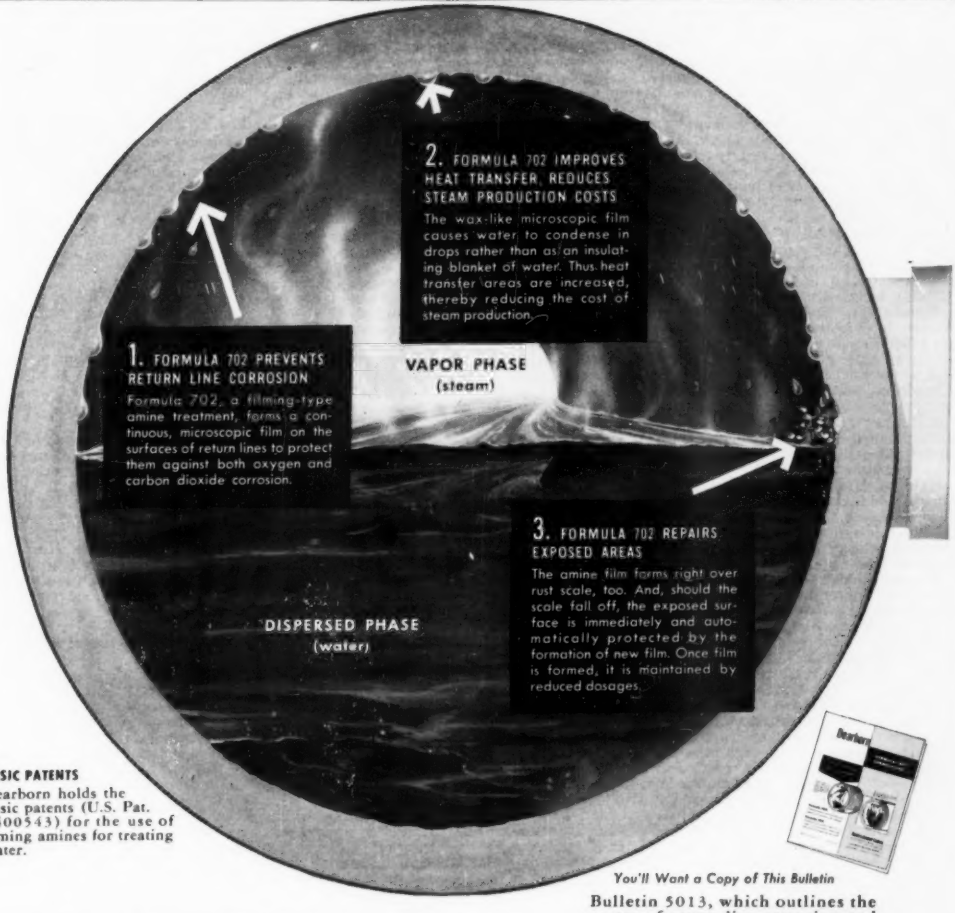
23—CONTROL INSTRUMENT

Is for automatic measuring and control of dust level in bins

Fly ash collected in a Cottrell Precipitator can be automatically measured and the bin level controlled by the Model 40 Rotax Controller, manufacturer announces. A temperature bulb, mounted inside the precipitator, senses the higher temperatures of the flue gases from which the dust is precipitated. When the dust deposit covers the bulb (acting as insulation) the controller, responding to the resulting lower temperature, completes an electrical circuit through its contacts to sound an alarm.

If desired, the controller can be installed to operate a screw conveyor or other motor-driven equipment, automatically emptying bin or tank when desired level is reached. The system is said to be equally effective for many other bulk materials, provided their temperature in the bin is considerably above or below ambient temperature. Details of an installation in a Midwestern public utility are given in Engineering Data Sheet 823-12. The Foxboro Co.

3 reasons why every power engineer should know about Dearborn Formula 702


2. FORMULA 702 IMPROVES HEAT TRANSFER, REDUCES STEAM PRODUCTION COSTS
The wax-like microscopic film causes water to condense in drops rather than as an insulating blanket of water. Thus heat transfer areas are increased, thereby reducing the cost of steam production.
1. FORMULA 702 PREVENTS RETURN LINE CORROSION
Formula 702, a filming-type amine treatment, forms a continuous, microscopic film on the surfaces of return lines to protect them against both oxygen and carbon dioxide corrosion.
VAPOR PHASE
(steam)
3. FORMULA 702 REPAIRS EXPOSED AREAS
The amine film forms right over rust scale, too. And, should the scale fall off, the exposed surface is immediately and automatically protected by the formation of new film. Once film is formed, it is maintained by reduced dosages.
DISPERSED PHASE
(water)

BASIC PATENTS
Dearborn holds the basic patents (U.S. Pat. 2400543) for the use of filming amines for treating water.

This cross-section of a return line, showing how *Dearborn Formula 702*, which is fed directly into the boiler, works to eliminate costly corrosion, reduce maintenance, avoid shutdowns and protect valuable equipment. If the pH value of your steam condensate is excessively low, it will pay you to discuss Formula 702 with your Dearborn Engineer.

DEARBORN CHEMICAL COMPANY • Merchandise Mart Plaza • Chicago 54, Illinois

You'll Want a Copy of This Bulletin

Bulletin 5013, which outlines the causes of return line corrosion and the method of cure with Formula 702, will be sent on request.

Dearborn Chemical Company Dept. PG
Merchandise Mart Plaza
Chicago 54, Ill.

( ) Send a copy of Bulletin 5013

( ) Have a Dearborn Engineer call

Name.....

Position.....

Company.....

Address.....

City.....*Zone*.....*State*.....

Dearborn

TRADE MARK REGISTERED

THE LEADER IN WATER TREATMENT AND RUST PREVENTIVES

For more data circle 529 on Post Card

POWER PLANT Construction News

Los Angeles, Calif. — Department of Water & Power, 207 South Broadway, plans early construction of new steam-electric municipal power plant. No official estimate of cost announced — will represent investment of several million dollars. It will be known as Valley power plant.

Stockton, Calif. — Sperry Flour Co., Division of General Mills, Inc., 116 New Montgomery St., San Francisco, Calif., plans power house at proposed new flour mill at Stockton, where site has been selected. It will consist of several one and multi-story buildings, and is estimated to cost close to $1,000,000. Work is expected to begin soon.

Tracy, Calif. — American Reinforced Paper Co., care of William A. Corlett, 347 Clay St., San Francisco, Calif., architect, plans steam power station at paper-manufacturing plant at Tracy. It will comprise several one and multi-story buildings, totaling 30,000 sq. ft. floor space, and is reported to cost about $525,000. Architect noted is in charge.

Wilmington, Del. — Delaware Power & Light Co., 600 Market St., has secured permission from Defense Production Administration to expend about $11,900,000 for expansion in electric generating stations. It is understood that large part of work will be carried out at Edge Moor, Del.

Paullina, Iowa — Municipal Light & Water Works, Paullina, has plans for extensions in municipal power plant, with installation of a new Diesel engine-generating unit and auxiliary equipment. No estimate of cost announced. Work is scheduled to be carried out at early date. Kruse Engineering Service, Spencer, Iowa, is engineer.

Galena, Kan. — Eagle-Picher Co., American Bldg., Cincinnati, Ohio, plans steam-generating station at proposed new plant at Galena, for zinc-roasting and sulfuric acid manufacture. It will comprise a number of buildings, equipped for large output, and is reported to cost close to $4,000,000. Work will be placed under way soon and is scheduled for completion early in 1954.

Rumford, Me. — Rumford Falls Power Co., Rumford, has plans maturing for new hydro-electric power plant, with installation to include two 6400-kw. hydraulic turbine-electric generator units, and auxiliary equipment. Also will make improvements in present plants. Entire development reported to cost over $4,000,000. Charles T. Main, Inc., 80 Federal St., Boston, Mass., is consulting engineer. Company is an affiliate of Oxford Paper Co., Rumford.

Weymouth, Mass. — Boston Edison Co., 39 Boylston St., Boston, has plans for expansion in Edgar steam-electric generating station at North Weymouth, including installation of a new turbine generating unit, high-pressure boilers and auxiliary equipment. Entire project is reported to cost over $25,000,000, with power substations, transmission lines and other operating facilities. Work is scheduled to proceed at once.

Rochester, Minn. — Libby, McNeil & Libby, Inc., Union Stock Yards, Chicago, Ill., prepared food products, plans steam power house at new branch processing plant at Rochester, to be one-story, totaling about 40,000 sq. ft. floor space. Entire project is reported to cost about $375,000. Work will be placed under way soon.

Gulfport, Miss. — Gulfport Glass Corp., Gulfport, recently organized, care of George P. Hopkins, 19th St., Gulfport, plans steam power house at new glass container plant on local site. It will consist of a main production building and several smaller structures. Entire project will cost approximately $500,000. Mr. Hopkins, noted, has contract for construction, and will begin work soon.

Joplin, Mo. — Missouri Farmers' Association, Columbia, Mo., plans steam power station at new commercial fertilizer plant near Joplin, where tract of 275 acres of land has been acquired. It will comprise several buildings for processing and general production, equipped for large capacity. Cost reported about $3,500,000. Proposed to begin work early in 1953.

Missouri City, Mo. — Northwest Electric Power Cooperative, Missouri City, has plans for new electric power plant, estimated to cost approximately $100,000. Work will begin soon. Lutz & May, Finance Bldg., Kansas City, Mo., are consulting engineers.

Olivette, Mo. — Carter Carburetor Corp., 2840 North Spring St., St. Louis, Mo., carburetors, parts, etc., plans boiler house at proposed new plant at Olivette, near St. Louis, where tract of 34 acres of land has been purchased. It will consist of several buildings, totaling 100,000 sq. ft. floor space. Cost reported close to $2,000,000.

St. Louis, Mo. — Gaylord Container Corp., 111 North Fourth St., plans steam power house at new plant on local site, for manufacture of corrugated and solid fibre shipping cases. Plant will total about 260,000 sq. ft. floor space, and is estimated to cost approximately $2,500,000. L. O. Stocker Co., 3928 Lindell Blvd., St. Louis, Mo., is engineer and contractor for building erection. Work will be carried out soon.

Billings, Mont. — Rocky Mountain Chemical Co., Inc., care of John Buttleman, Willow Creek, Mont. (an official of Manhattan State Bank, Manhattan, Mont., being organized by Mr. Buttleman and associates, plans power house at proposed new plant for production of ammonium nitrate, on site near Billings. It will comprise several large units for processing and manufacture. Cost reported about $7,500,000. Proposed to begin work early in 1953.

Omaha, Neb. — Continental Can Co., 100 East 42nd St., New York, N. Y., plans steam power house at proposed new plant near Omaha, where tract of 40 acres of land has been acquired. It will comprise several buildings, equipped for large output, and is reported to cost close to $5,000,000. Proposed to begin work at early date.

Mineola, L. I., N. Y. — Long Island Lighting Co., Mineola, has approved plans for new steam-electric power plant at Glenwood Landing, with installation to include generator, high-pressure boiler and auxiliary equipment. No official estimate of cost announced. Contract has been awarded for structural steel framing and work is expected to be placed under way soon.

Wilmington, N. C. — Carolina Power & Light Co., Raleigh, N. C., has secured permission from Defense Production Administration to proceed with construction of proposed new steam-electric generating station on Cape Fear River, near Wilmington, previously noted in these columns, and work is being placed under way. It will be equipped for a rated capacity of 110,000-kw., and is estimated to cost close to $17,000,000, with power substations, transmission lines, etc.

Jackson, Ohio — Globe Iron Co., Jackson, plans steam power house at proposed new plant at Beverly, near Jackson, where site has been selected. It will be used for manufacture of electric furnaces and parts. Several one-story buildings will be erected. Entire project is reported to cost close to $2,000,000. United Engineers & Constructors, Inc., 1401 Arch St., Philadelphia, Pa., is engineer and will be in charge of construction.

South Point, Ohio — Allied Chemical & Dye Corp., Nitrogen Division, 61 Broadway, New York, N. Y., plans steam-generating plant at proposed new factory at South Point, where site has been secured, for manufacture of commercial fertilizer products. It will comprise a number of units, equipped for large capacity, and is reported to cost approximately $5,000,000. John J. Harte Co., 284 Techwood Dr., Atlanta, Ga., is engineer, and will be in charge of construction.

Toledo, Ohio — Toledo Edison Co., Edison Bldg., plans new steam-electric generating station on site near city, where large tract of land has been selected. It will be equipped for an initial capacity of 125,000-kw., and is estimated to cost about $25,000,000, with power substations, transmission lines and other operating facilities. New plant will be designed for installation of four additional generating units in future. Proposed to begin work early in 1953 and to have station ready for service in summer of 1955.

Tulsa, Okla. — Public Service Co. of Oklahoma, 600 South Main St., has secured permission from Defense Production Administration to carry out expansion in electric power facilities, including generating stations, power substations, transmission lines and other operating facilities, estimated to cost close to $9,000,000. Work will be paced under way at once.

Bryan, Tex. — International Shoe Co., 1059 Washington Ave., St. Louis, Mo., plans boiler plant at proposed new factory at Bryan, where tract of land has been secured. It will comprise a main building for general manufacture and several smaller units for auxiliary service. Cost reported about $750,000. Brown & Root, Inc., 4100 Clinton Dr., Houston, Tex., is engineer and will be in charge of erection.

Floydada, Tex. — Municipal Electric Dept. has plans for extensions and improvements in municipal oil engine-operated electric plant. Cost reported over $100,000. Work will be carried out soon.

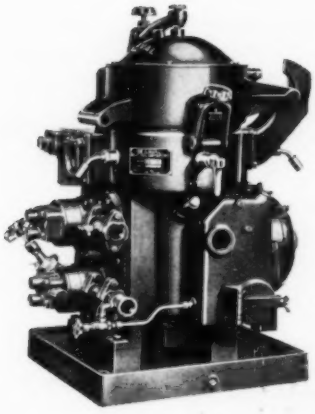
Lone Star, Tex. — Southwestern Gas & Electric Co., Shreveport, La., will have plans prepared by Sargent & Lundy, Inc., 140 South Dearborn St., Chicago, Ill., consulting engineer, for proposed new steam-electric generating plant in vicinity of Lone Star, recently noted in these columns. It will be equipped for an initial capacity of 40,000-kw., and is estimated to cost about $3,500,000, with power substations, transmission lines and other operating facilities.

Richland Center, Wis. — Richland Center Municipal Utilities has plans for extensions and improvements in municipal steam-electric power plant, with installation of additional equipment. No estimate of cost announced. Carroll, Bechtel & Langtry, 228 North LaSalle St., Chicago, Ill., are consulting engineers.

NO GETTING AROUND IT

DE LAVAL OIL PURIFIERS STOP TROUBLE BEFORE IT STARTS

De Laval Centrifugal Oil Purifiers remove ***both*** of the chief causes of lubricating oil deterioration —dirt and water. They are positive insurance against the trouble that impure lubricating oil can cause.



A De Laval Oil Purifier does its job thoroughly. Water is discharged continuously after being removed from the oil by centrifugal force, and the dirt is stored in the bowl, outside the zone where purification takes place.

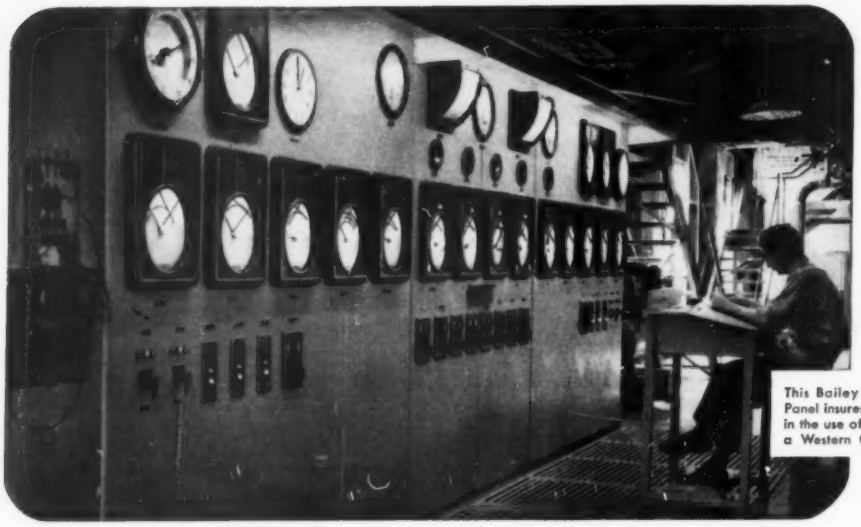
De Laval Oil Purifiers have another important advantage — they have enough reserve capacity to take care of a sudden emergency, such as a surge of water due to a leak.

THE DE LAVAL SEPARATOR COMPANY
Poughkeepsie, New York 427 Randolph St., Chicago 6
DE LAVAL PACIFIC CO., 61 Beale St., San Francisco 5
THE DE LAVAL COMPANY, Limited, Peterborough, Ont.

De Laval

LUBRICATING OIL PURIFIERS

For more data circle 530 on Post Card



This Bailey Boiler Control Panel insures high efficiency in the use of Fuel-Dollars at a Western Chemical Plant.

What's Your Fuel-dollar Efficiency?

A dollar's worth of fuel has the *same potential* energy, no matter who's boiler it fires. But how much of the energy actually gets converted to a usable form depends on how you operate your boiler.

That's where Bailey Controls can help. And, here's why, we believe, you'll get better fuel-dollar efficiency with Bailey:

1. **Complete Range of Equipment—fully co-ordinated.** You need never worry that a Bailey Engineer's recommendation is slanted in favor of a particular type of equipment, just because he has a limited line to sell—or that Bailey will pass the buck for efficient control; we offer *complete* boiler control systems.

2. **Engineering Service—backed by experience.** No other manufacturer of instruments and controls can offer as broad an experience, based on successful installations involving all types of combustion, flow measurement and automatic control.

3. **Direct Sales-Service—conveniently located near you.** Bailey Meter Company's Sales-Service Engineers are located in more industrial centers than those of any other manufacturer of boiler control systems; you get prompt, experienced service with a minimum of travel time and expense.

•

For better fuel-dollar efficiency—for more power per fuel-dollar, less outage and safer working conditions, you owe it to yourself to investigate Bailey Controls. Ask a Bailey Engineer to arrange a visit to a nearby Bailey installation. We're proud to stand on our record: "More power to you!"

A-109-1

BAILEY METERS

BAILEY METER COMPANY

1040 IVANHOE ROAD
CLEVELAND 10, OHIO

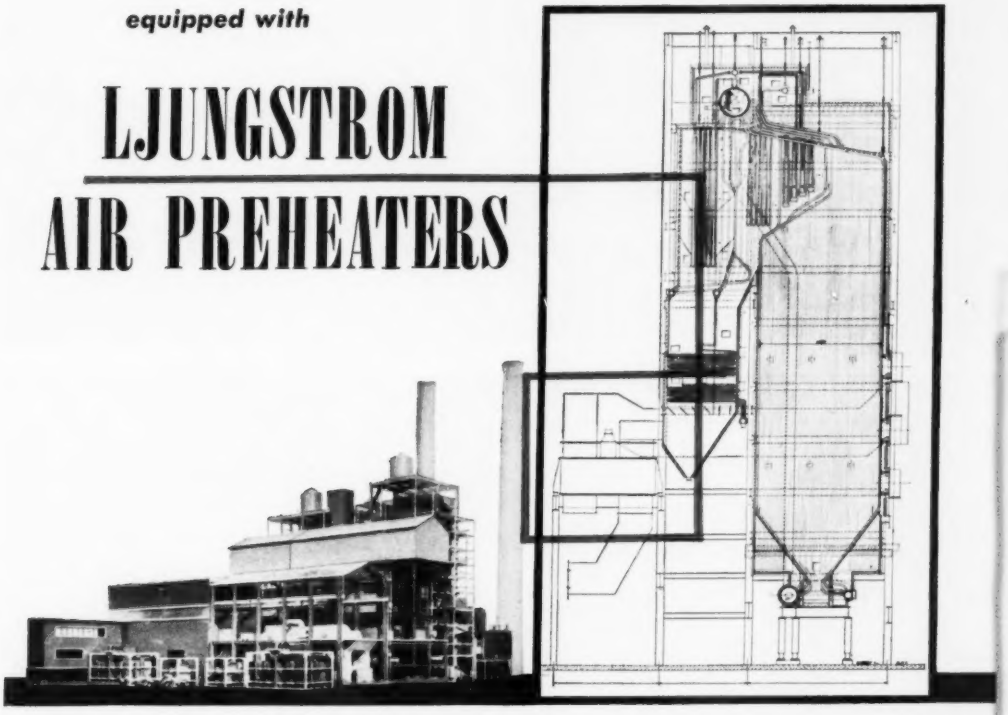
Controls for Steam Plants

For more data circle 531 on Post Card

Boilers at new Gadsby Steam Plant of the Utah Power & Light Company . . . .

equipped with

LJUNGSTROM AIR PREHEATERS



Utah Power & Light Company's new Gadsby Steam Plant, designed by Bechtel Corporation, will utilize, on completion, two Riley Steam Generating Units totalling 1,195,000 pounds of steam per hour capacity.

One unit, shown here, went on the line last August. Fired with petroleum pitch and designed for future pulverized coal firing, it generates 620,000 pounds of steam per hour at 1500 psi and 955 F. The second boiler is scheduled to begin operation late this year. Its capacity will be 575,000 pounds of steam per hour. This unit is designed for 1700 psi and 1000 F, with a reheat cycle at 396 psi and 1000 F. It will be fired with pulverized coal, and will have firing equipment for petroleum pitch.

Each of these modern steam generating units has been designed to incorporate a Ljungstrom Air Preheater. The Ljungstrom now in service preheats combustion air to 642 F, cools stack gases to 305 F. The Ljungstrom on the second unit will preheat air to 650 F, cool exit gas to 315 F.

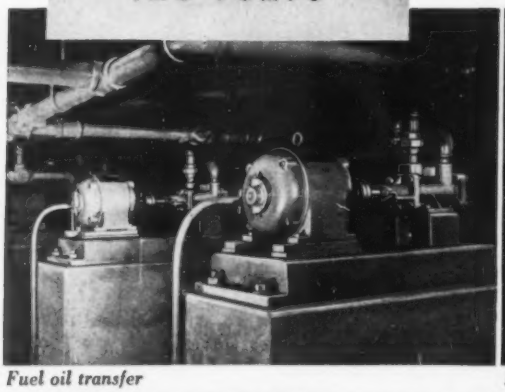
This is another example of the unanimity with which boiler manufacturers have included Ljungstrom Air Preheaters in outstanding recent installations. The effectiveness and dependability of the Ljungstrom Air Preheater have made it a standard for high efficiency steam generating units.

THE Air Preheater Corporation 60 East 42nd St., New York 17, N. Y.

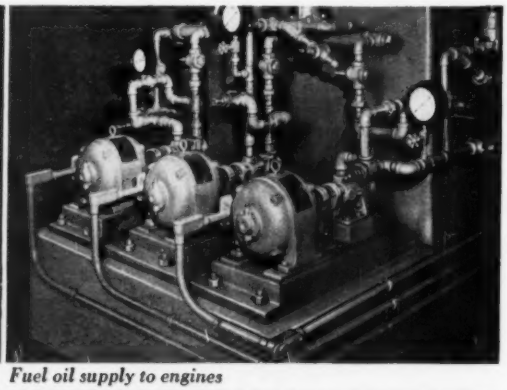
For more data circle 532 on Post Card

DE LAVAL
IMO PUMPS

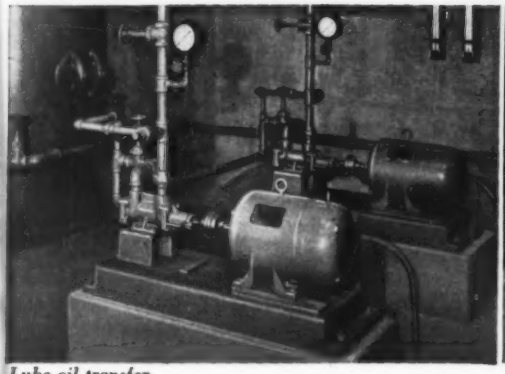
hold down 4 jobs at Owl's Head



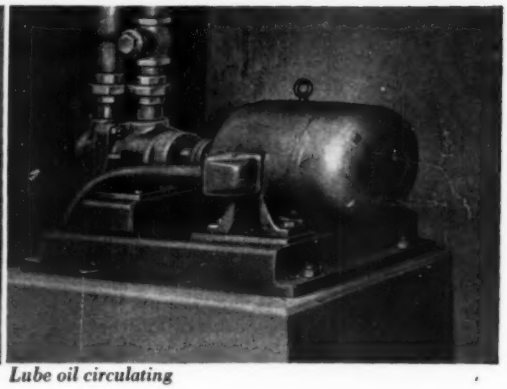
Fuel oil transfer



Fuel oil supply to engines



Lube oil transfer



Lube oil circulating

Again De Laval IMO rotary pumps prove their versatility. Eighteen of them are handling all the fuel and lube oil services for the six National Supply Company dual-fuel engines in the new Owl's Head sewage treatment plant in Brooklyn, New York.

The unique IMO design—*with only three moving parts*—assures long, trouble-free performance. IMO pumps are quiet, pulsation-free, compact and excellent for direct-connected high-speed operation.

Whether your power source is dual-fuel, gas or diesel engine, or oil-fired steam, be sure to specify IMO pumps for your next oil handling job. Use them in high and low pressure fuel oil burner sets, pumping fuel oil to burners, unloading and transferring fuel and diesel oil, handling oil for lighting off service and providing pressure lubrication on pumps and turbines. Send for Bulletin LG showing complete IMO line for capacities to 1,000 gpm at pressures to 500 psi and for capacities to 150 gpm at pressures to 1,500 psi.

DE LAVAL *IMO Pumps*

DE LAVAL STEAM TURBINE COMPANY
816 Nottingham Way, Trenton 2, New Jersey

DL 187

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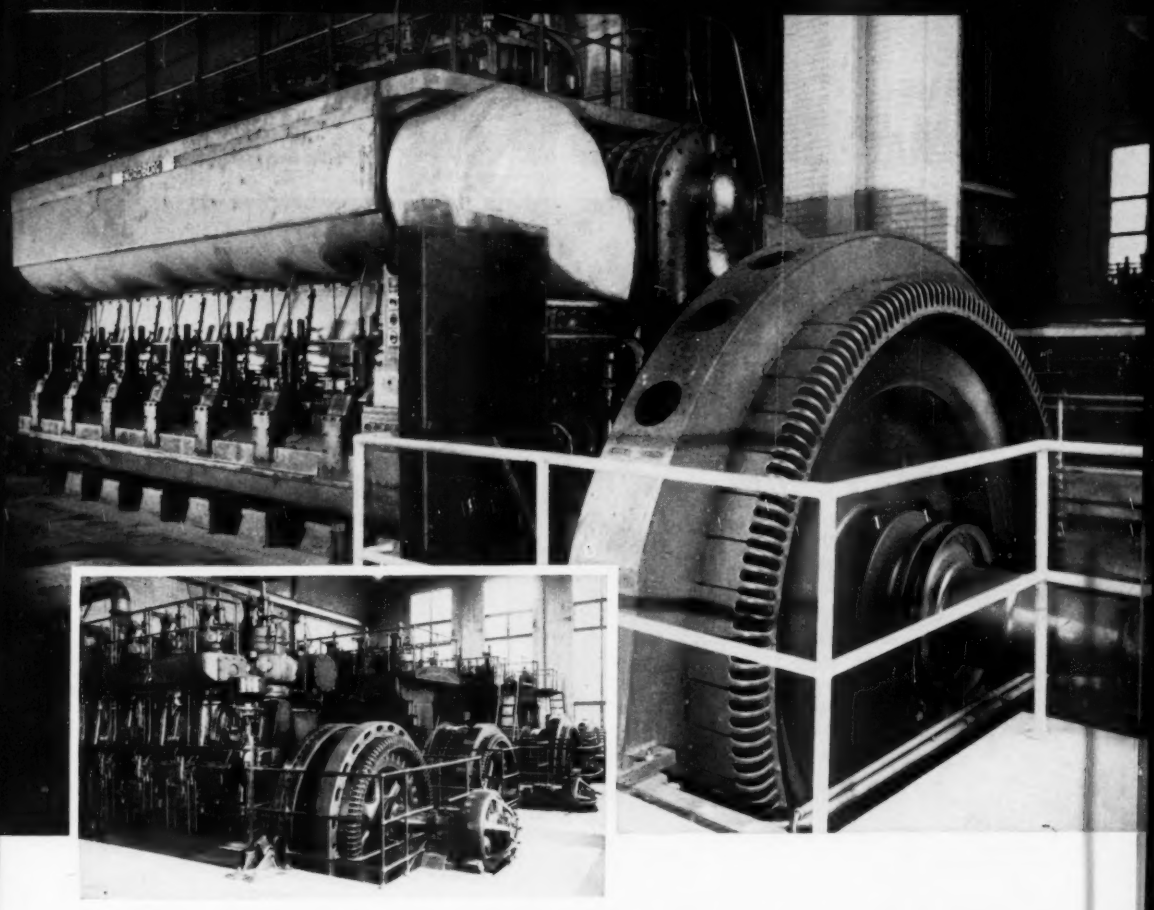


Rensselaer, Indiana, plant gets record economy with...

● Shown above are the five diesel engines, totaling 7,150 hp., which make the Rensselaer municipal plant one of the largest of its kind in Indiana. The efficient operation of these diesels has helped keep Rensselaer's lighting rates among the lowest in the state for cities in the 2,500 to 10,000 population group.

Contributing to this successful record, Standard Oil's diesel fuel and lubricants have helped keep operating and maintenance costs low. STANDARD HD Oil has played a particularly important role. This outstanding heavy-duty lubricant has provided effective lubrication of vital cylinder areas. It has kept cylinders and rings protected against excessive wear and free from deposits. How these benefits contribute to high operating efficiency is shown by the performance of the plant's newest and largest diesel, a 2,800-hp unit. In a typical month, this unit has operated for 444 hours, carried an average load of 54%, and generated 13 kw-hr per gallon of fuel with a lubricant consumption rate of 9.414 hp-hr per gallon.

Throughout the Midwest, diesel operators are getting record efficiency and economy with the help of STANDARD HD Oil. The Standard Oil lubrication specialist in your area will be glad to give you information concerning the use of this superior heavy-duty lubricant in plants with which you may be familiar. Just phone your local Standard Oil Company office for his services. Standard Oil Company, 910 S. Michigan Ave., Chicago 80, Illinois.

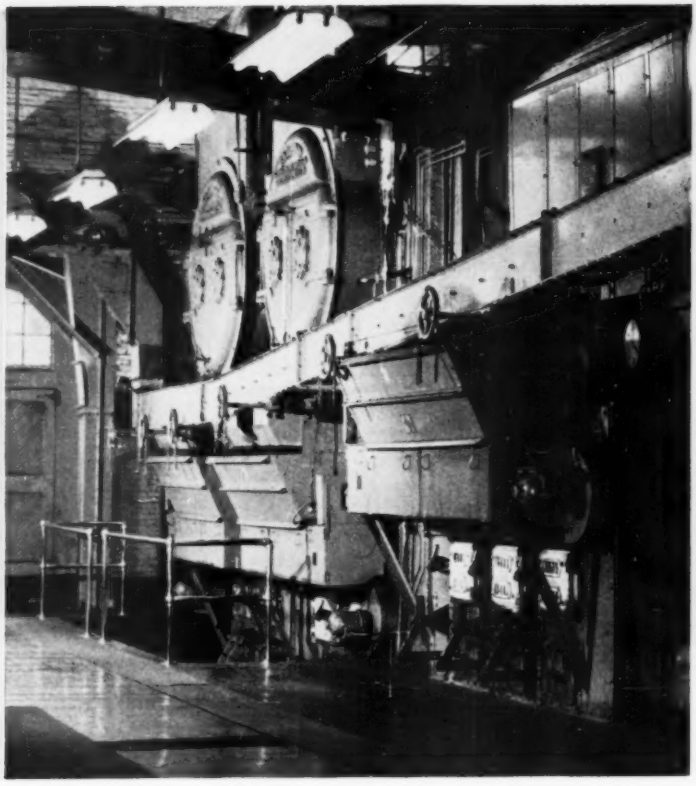
STANDARD HD
TRADE MARK
OIL

STANDARD OIL COMPANY

STANDARD (*Indiana*)

"WE SAVE MORE THAN $50,000 A YEAR—

This modernized steam plant will pay for itself in 3 years! The two new boilers shown on the extreme right now carry the complete plant load. They replaced five boilers of the type shown on the left—two of which are still in standby service. The new equipment saves Worumbo nearly 30¢ on every thousand pounds of steam. Automatic, dustless coal and ash handling has helped cut weekly labor costs from $606 to $242! The new plant has a 20% greater capacity—burns 150 *fewer* tons of coal each month.



● Today coal can give you more steam per dollar than ever before. With modern combustion equipment, you can get anywhere from 10 to 40% more power from a ton of coal than was possible a few years ago. And with up-to-date automatic coal- and ash-handling systems you can cut labor costs to a minimum.

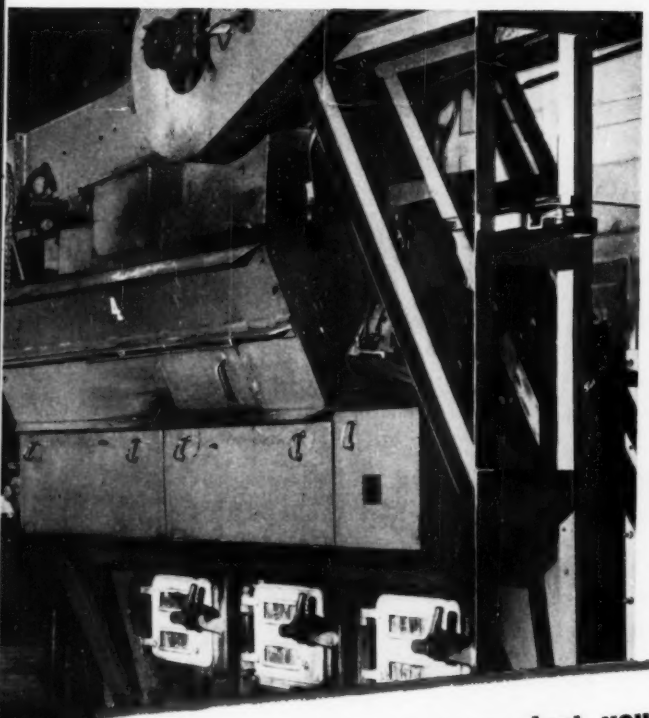
If you're building a new plant, or planning to modernize, get the advice of a consulting engineer. He'll show you the way to *big* savings—burning coal in a modern plant designed to meet your specific needs.

Powering your plant with coal makes good sense for the future, too. Coal is the only fuel with really abundant reserves—enough to last for centuries. And this coal is supplied by the world's most efficient and productive coal industry. That's why coal is the only fuel that can offer dependable future supply and greater relative price stability.

BITUMINOUS COAL INSTITUTE
A Department of National Coal Association
WASHINGTON, D. C.

FOR HIGH EFFICIENCY—FOR LOW COST

BY BURNING COAL THE MODERN WAY!"



"MODERNIZING OUR COAL INSTALLATION CUT OUR FUEL CONSUMPTION 21.4%...LABOR COSTS 60%!"

says Oliver Moses, 3rd, President, Worumbo Manufacturing Company, Lisbon Falls, Maine—makers of nationally advertised WORUMBO FABRICS.

If you operate a steam plant, you can't afford to ignore these facts!

COAL in most places is today's lowest-cost fuel.

COAL resources in America are adequate for all needs—*for hundreds of years to come.*

COAL production in the U.S.A. is highly mechanized and by far the most efficient in the world.

COAL prices will therefore remain the most stable of all fuels.

COAL is the safest fuel to store and use.

COAL is the fuel that industry counts on more and more—for with modern combustion and handling equipment, the inherent advantages of well-prepared coal net even bigger savings.

YOU CAN COUNT ON COAL!

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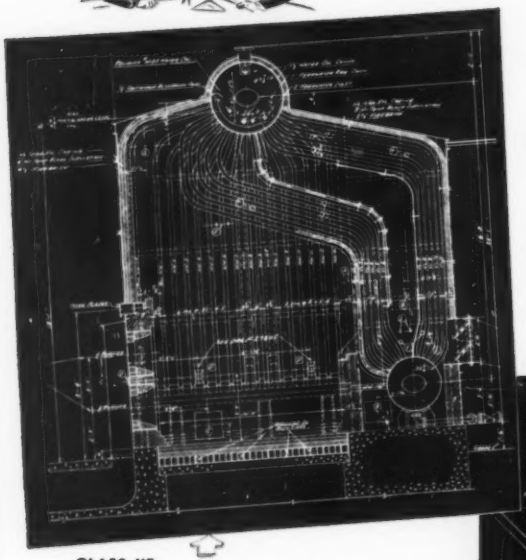
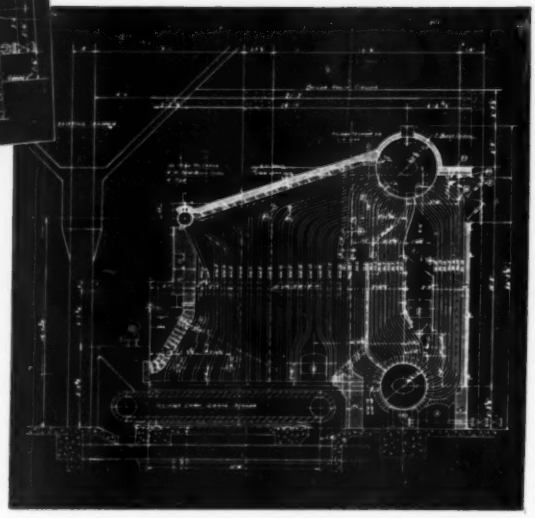
Industry Approved

Two-Drum
STEAM GENERATORS
by Vogt



CLASS VF
A 22,000 pounds steam per hour unit installed at Indiana Farm Bureau Refinery, Mt. Vernon, Ind.



CLASS VS
The Seelbach Hotel, Louisville, Ky. is served by this 30,000 pounds steam per hour boiler.

A wide variety of industrial plants and other users of steam for power, processing, or heating have found these efficient Vogt Two-Drum Type Boilers to be the answer to their diverse steam generating requirements.

Class VF units provide maximum capacity in limited floor space and head room, while Class VS is best adapted to installations not having such restrictions. Each has a large furnace volume and a high ratio of radiant heating surface. The furnace design assures proper combustion of fuels fired in suspension or with various type or stokers.

A bulletin with general information and showing typical installations is available on request.

Typical Users...

FOOD PROCESSING PLANTS

DISTILLERIES • HOTELS

HOSPITALS • CHEMICAL PLANTS

PETROLEUM REFINERIES

HENRY VOGT MACHINE CO., Louisville 10, Kentucky

BRANCH OFFICES: NEW YORK, PHILADELPHIA, CLEVELAND, CHICAGO, ST. LOUIS, DALLAS, CHARLESTON, W. VA.

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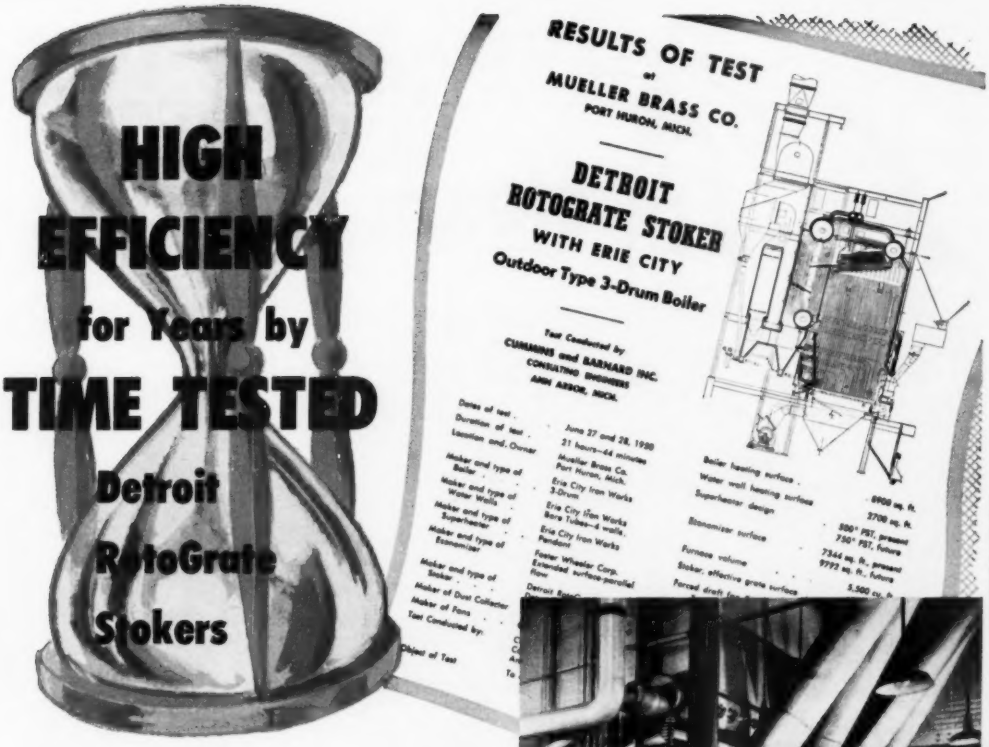
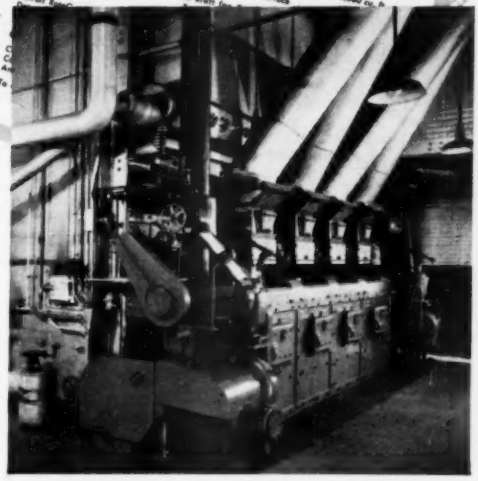


Results of tests of the Mueller Brass new steam generating unit by the consultants were most gratifying. They are typical of Detroit RotoGrate Stoker performance.

Especially important to you as a buyer is the *test of time.* Performance records of the RotoGrates in hundreds of plants—show high overall thermal efficiency, high availability and extremely low maintenance with all grades of coal.



Detroit RotoGrate Stoker applied to the 110,000 pound unit at Mueller Brass Co., Port Huron, Mich.

Write for Detroit RotoGrate Bulletin

There is a Type and Size Detroit Stoker for Every Industrial Need

Detroit Stoker Company

For more data circle 537 on Post Card

traps help uncover hidden steam treasure

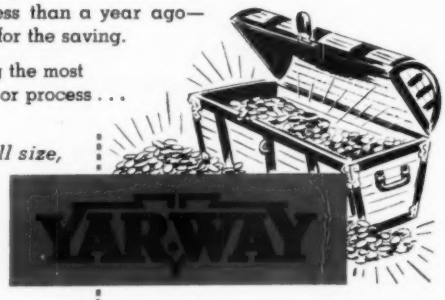
The facts are these:

A large southern chemical company about a year ago was up to capacity on their boilers. New process units were being added, requiring more steam—a new boiler seemed inevitable.

About that time they began replacing their old-type traps and bleed-off valves with Yarway Impulse Steam Traps and Strainers. Today, even with the new process units added, their daily steam consumption is nearly 100,000 lbs less than a year ago—the superintendent gives Yarway Impulse Traps credit for the saving.

Yarway Impulse Traps are *designed* to insure sending the most premium B.T.U.'s at top temperature into your product or process . . . *to get equipment hotter sooner and keep it hot!*

Yarway's have 11 other advantages, too—such as *small size, low maintenance, low cost, and availability* from over 200 Industrial Distributors. Write for Bulletin T-1740. Or for steam trap advice, call on your nearby Yarway service engineer.



YARNALL-WARING COMPANY
114 Mermaid Avenue, Philadelphia 18, Pa.

the steam trap designed with more production in mind

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LETTERS TO THE EDITORS

Shawnee – Important Correction

IN THE ARTICLE entitled Shawnee — TVA to AEC, under my signature, POWER ENGINEERING, September 1952, page 74, a serious error occurred in Fig. 4, page 76, the heat balance diagram. In the caption for that diagram, the design heat rate is listed at 9303 Btu per kwh. This is correct for the heat balance originally submitted, which was for 1½ in. Hg absolute. However, the heat balance diagram as printed gives this figure of 9303 at the same time that it shows a condenser vacuum of 1 in. Hg absolute.

Under 1-in. conditions, the generator output is 152,660 kw at a net plant heat rate of 9219 Btu per kwh. This represents an error of approximately 1 per cent in the efficiency of the plant. To any power plant engineer who knows heat balances, the figure which appears in print in the article is penalized that much when compared to other plants of similar characteristics.

Knoxville, Tenn. H. J. PETERSEN

Editor's Note: — This is really a serious engineering error and not one of those minor typographical errors that can be glossed over by the editor's "Oops! Sorry." Our checking procedure is set up to verify values on drawings but in some way this one slipped through three pairs of gimlet eyes and we don't feel flippant about it.

Paint Tests

BY THIS TIME, I suppose you have heard howls of anguish from the paint companies about L. G. Jones' article on making your own tests of power plant paint (October issue, page 70). But they shouldn't howl about it. Instead, the reputable paint company should welcome Mr. Jones' data, for they are based on what one power-company actually did. Furthermore, one of the salesmen who has been calling on me about paint for one of our power plant painting jobs thinks it's good stuff. He says it will help him and will back up all the high-powered testing his own company does.

This salesman tells me he is sure his paint would come out tops in any such test. He says this test is practical, quick and it is made and evaluated by the user himself in a good attempt to be impartial.

Seems to me, too, this is good practical stuff on something you can do yourself to get a quick and reliable test of paint — and good painting is important in and around any power plant.

If L. G. Jones can give us more along this line about properties of paint, as he says at the end of his article I, for one, would like to have it.

Dallas, Texas PAUL BASKIN

Editor's Note: — He can and you will.

Feedwater in Illinois State Power Plants

JUST AS THE ABOVE article, November issue, page 91, was coming off the press, the author asked us to add the following statement to the caption of Fig. 3. Figure 3 shows the relationship between potential carbon dioxide and inches of penetration per year. It should carry the following explanatory note:

"The data pertaining to Plant 29 were obtained previous to the application of filming amine. Since the application of filming amine, corrosion has been reduced by 90%."

Hotwell Pump

AS YOU SAY, the brethren certainly did rally round to help out on the problem of the hotwell pump, Answer No. 497 — What Can He Do About This Hotwell Pump — October 1952 issue. Practically everybody had an inexpensive and practical solution to the problem and certainly M. P. should be able to work it out with all that high-powered help. These fellows that commented so practically on the question certainly have been through the mill of pumping problems.

On one minor point I am going to raise a question and that is on Fig. 3, page 84, showing an air bubbler type of pneumatic control, which you say is least expensive recirculation system discussed.

That may very well be; but I am just wondering whether you are going to put enough air into that water in the hotwell to have any effect on the deaerator or deaerating heater that follows it. Also, is there any chance of that air going through the pump?

I don't think either of these things is very serious but it might be something to check.

Chicago, Illinois AMBITIOUS AL

Water, Water, Water

WATER TREATMENT ENGINEERING by L. W. Fitzpatrick (August, September, October issues) starts off its windup very well, I think. By windup I mean that Mr. Fitzpatrick has to start by explaining some of the fundamental chemistry involved in water treatment, before he can get down to the engineering of it. But I think he is doing it in a very practical way, without all the complicated chemical equations and theoretical considerations that the water chemists usually put out.

In particular, I liked his explanation of What Are Phosphates? and am glad that you set it off in a box the way you did in the October 1952 issue. Also, the data on combining rate of calcium to phosphate.

If Mr. Fitzpatrick in his future articles works into the practical aspects of water treatment engineering, as you promised he would in your August issue, I think he will have something that will appeal to practically every reader of POWER ENGINEERING.

Keep up the good work you and Mr. Fitzpatrick have started on this very vital subject.

Chicago, Ill. D. H. EATON

Modernization Pays Off

TWO ARTICLES in the October issue were especially interesting to me — Modernization at Container Corp., page 68, and How We Saved Power and Refrigeration Dollars, page 108.

In the first, Mr. Congreve shows how his well-known company took an old power plant at one of its factories and modernized it so that coal consumption per unit of product was cut nearly one-third. This is a notable saving and I hope it will provide an example for other industries to follow. Most industrial managements today will modernize their power plants when it is clear they are costing too much.

The other case, however, that Mr. Lohkamp told about, makes one wonder how they ever operated the power plant at all, with the losses that were going on. It's a credit to both the equipment itself and to the operators that with long, uninsulated steam lines, improper trapping, low power factor, and a good deal of scale and slime in equipment, they were able to do anything with it at all.

Even though it took a long time to get all the details worked out, Mr. Lohkamp deserves a great deal of credit for his fine accomplishments.

Chicago, Illinois C. E. REED

Power Plant Noise

THE ARTICLE on how Acme Station installed acoustical ceilings, in making new dispatcher's office and laboratory in an old building (September issue, page 78), showed valuable installation details.

We have two diesel-engine generators, a steam-engine generator, a motor-driven air-compressor and the usual auxiliaries. For some reason, the engine room is so noisy you can't hear people talk or even shout in it. We are now going over all details to make sure the machines themselves are as quiet as possible.

But until we saw your article, we hadn't thought much about the use of acoustical material on walls and ceiling. That might quiet the room down. We'll look into it.

Detroit, Mich. HAROLD MACKENZIE

Kanawha and Muskingum Plants Add

Two new steam electric plants now under construction, Kanawha River and Muskingum River, will each have two huge cross-compound turbine generators and an initial capacity of 400,000 kw. They will shortly join the list of major stations in American Gas & Electric Co.'s system

TWO NEW STEAM electric power plants, Kanawha River and Muskingum River, will shortly join the growing list of American Gas and Electric Company's major plants installed within the past 8 years — Tidd[1], Philip Sporn[2] and Tanners Creek[3].

Plans for construction of the Kanawha River Plant, located at Glascow, W. Va., 22 miles upstream from Charleston, were announced in August, 1950, by the Appalachian Electric Power Company and AG & E. Then, in February, 1951, a similar announcement was made by The Ohio Power Company of the Muskingum River Plant, near Beverly, O., and about 46 miles downstream from Zanesville.

Development of the sites and ultimate decision to build was formed as part of the long-range program of continued expansion of system generation facilities to a point more than double present levels. Receiving special attention were fundamentals requisite to an economical and continuing fuel supply.

A transmission map of the AG & E system shows service primarily to small communities. None of the 2260 communities served, with a combined population of nearly 4,581,000, is larger than 150,000. The area, however, is highly industrialized with coal, steel, chemical and manufacturing operations. Industrial decentralization is spurring growth of these industries far above growth from basic or accelerated expansion. Rapid increase in load demand can be clearly seen, making it necessary to begin planning now for future system loads up to as high as 6,000,000 kw.

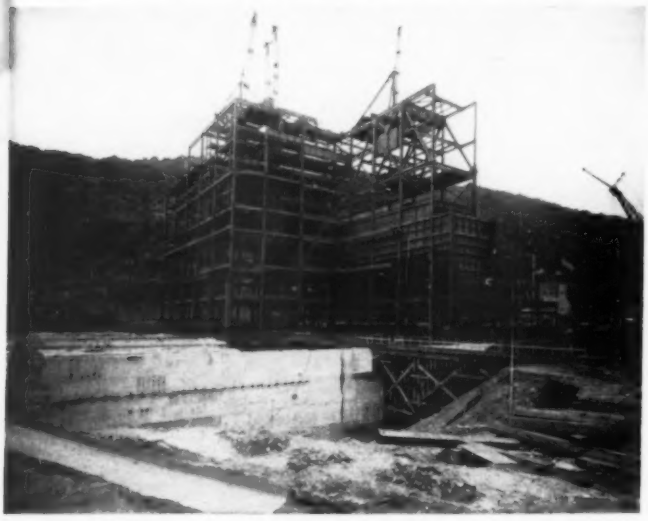
Sites for the two plants[4] were carefully chosen to provide ample acreage not only for plant, sub-station, coal handling and disposal, but in the case of Muskingum, additional land attractive to industry. In addition, flood plain was taken into consideration to avoid expensive protective structures.

Condensing water is more than adequate on AG & E's Ohio River plants, but for Kanawha and Muskingum, on Ohio River tributaries, some auxiliary condensing water cooling facilities may be involved if either goes beyond 600,000 kw.

The plants are well placed in respect to system load centers and so that they may be integrated into the existing transmission network. Network extensions can also be made economically. This was one of the most important factors influencing final site selection.

Total capacity of the five stations under construction since 1944 will be over 2,000,000 kw and increase system capacity to 4,019,000 kw by 1954. Philip Sporn plant is largest with 600,000 kw — Kanawha and Muskingum will each have 400,000 kw. Potential capacity is more than 4,700,000 kw; if needed, could be expanded to 5,000,000 kw.

Fig. 1. General view of the Kanawha River Plant, looking southwest, as it looked in late June, 1952



Coal a Major Factor

Coal presents a major problem in system planning, design and operation. Fundamental requirements to solution of a coal supply problem involve adequacy, reliability and characteristics of the supply, and economics of the fuel. Extensive natural gas deposits or lines in the area makes it necessary to have the highest economical use of energy to permit electric load development.

Of the system's total generating capacity, 72 per cent is located in the coal fields of Ohio and West Virginia. In the case of three plants, including Muskingum, locations permit transporting of coal to the plant by belt conveyor. Nearly 50 per cent of the system capacity will be operated on strip-mined coal by 1954.

In designing to improve heat rates and reduce operating costs while keeping investment low, it was recognized that increased size of units would be of help. Boiler design also had great influence on unit size. Studies were made of: (1) cycles with two reheats; (2) cycles using single-shaft high-speed units; (3) cycles using pressures higher than 2000 psi up to 5000 psi; and (4) cycles using high steam temperatures, primary and reheat, up to 1200 F.

Decision was reached, in favor of largest units adaptable to the system without disturbing reserve requirements or operating and maintenance schedules, to use 200,000-kw (net)

[1] The Tidd Plant of The Ohio Power Co., POWER ENGINEERING, March, 1947, page 68.
[2] Philip Sporn & Twin Branch to Have 2000-psi, 1050 F and 1000 F Reheat Cycles, POWER ENGINEERING, September, 1948, page 58.
[3] Tanners Creek, POWER ENGINEERING, September, 1951, page 56.
[4] Data in this article adapted from ASME papers Nos. 51-A-115, 51-A-116, 51-A-117.

200,000-kw, 1050-F Units To AG&E

cross-compound units, limit throttle pressure to 2000 psi, and to utilize 1050 F, primary and reheat, steam temperatures. This combination will be capable of developing a net continuous output of 200,000 kw at a heat rate of slightly more than 9000 Btu per net kwh.

Kanawha and Muskingum River Plants will have a minimum possible variation in design. They are very nearly alike except for differences in boilers. Kanawha River boilers will be of dry-ash-pit design, and Muskingum boilers will be fluid-bottom.

At Kanawha, shown in Figs. 1 and 2, all equipment is housed within the building except fans, air heaters, dust collectors and connecting ductwork. Studies of outdoor and semi-outdoor design indicated no substantial saving over that chosen. Equipment was arranged to give compact and economical layout, demonstrated by low volume of building structure per kw of installed capacity — 19.3 cu ft per kw, including service and office facilities.

Remote operation through centralized control rooms has made possible the location of the control room on the turbine room roof without detrimental effect on plant operation. It also had a material effect on building volume and economy. At Muskingum, shown in Figs. 3 & 4, the site provided better foundation conditions than those existing at Kanawha, so it was not necessary to use bearing piles to support any part of the structure.

Turbine Generators

Turbine generators are cross-compound with gross capability of each expected to reach 217,260 kw, operating with 1½-in. mercury back pressure. Two emergency stop valves are being furnished for each unit to accommodate large steam volumes. Steam at 2000 psi and 1050 F will enter these valve inlets and flow to the turbine proper via 6 control valves and connecting pipe lines. Use of such an external valve chest makes possible concentration of high temperatures on a relatively small and reasonably symmetrical portion of the high pressure turbine shell and makes feasible use of a forged valve chest.

High pressure steam entering the high pressure unit travels through 8 stages and discharges to the reheater at 490 psi, when at gross capability. Returning from the reheater at 1050 F, steam again enters the high pressure unit and flows toward the coupling end through 3 stages. Steam then leaves the high pressure turbine and enters the intermediate section of the low pressure turbine through two massive intercept valves. Steam pressure at these valves will be about 260 psi at maximum load. The low-pressure steam is expanded through 16 single-flow stages and 4 similar double-flow stages.

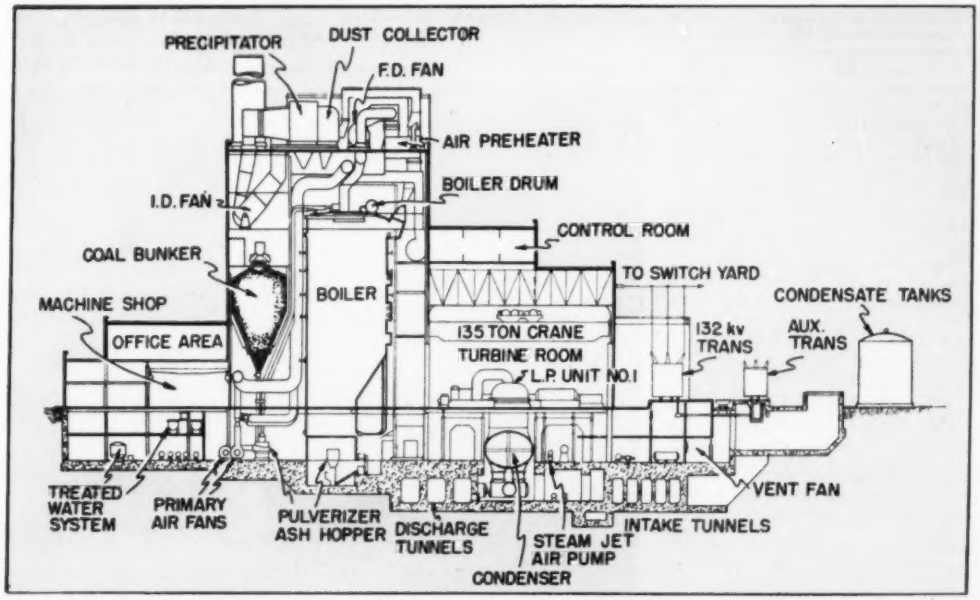
Adoption of steam seals instead of water seals will provide greater operating flexibility. Usual difficulty in adjusting shaft water seals while bringing units to synchronous speed or changing load will be eliminated. Rapid starting of units will be simplified. Serious thermal shocks to turbine shafts can be avoided. In addition, the system is simplified and less subject to mechanical trouble and maintenance.

A single high-pressure pump on the high pressure turbine shaft will furnish all hydraulic and bearing lubricating oil for high and low pressure turbines. The double-suction pump will operate at 3600 rpm and deliver oil at 200 psi.

The Boilers

Kanawha River boilers are equipped with dry bottom type furnaces in order to handle high ash fusion coals. Each boiler is designed for furnace heat input of 1,840,000,000 Btu per hr. These are among the largest boilers ever projected on a heat input basis. Primary steam flow is 1,335,000

Fig. 2. Cross-sectional view of the Kanawha River Plant. Note control room on top of the turbine room. Section at low-pressure element of turbine generator



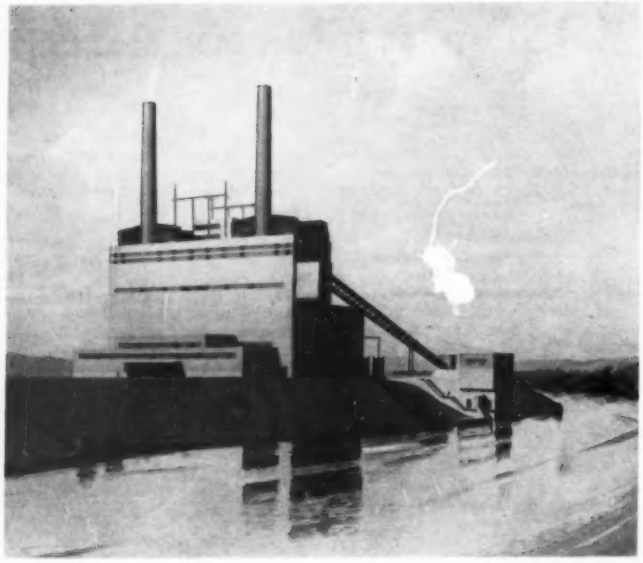


Fig. 3. An artist's conception of the two-unit Muskingum River Plant as it will look when it is in operation

lb per hr, and reheater flow is 1,216,000 lb per hr. Furnace will be 56-ft wide by 27-ft deep, with an average height of 90 ft.

Each boiler will consume about 80 tons of coal per hr, using 8 pulverizers, 7 of which can carry full load burning the poorest quality of coal contemplated (15 per cent ash, 10 per cent moisture and 40 grindability).

Each boiler will have 3 Ljungstrom regenerative air preheaters to bring combustion air to 550 F. Three induced draft fans, equipped with shutoff dampers and bulkheading arrangements to permit maintenance while in operation, and two forced draft fans, sized and motored for full pressurized furnace operation, will be used on each boiler. Boilers will probably operate without induced draft fans about 95 per cent of the time.

Only convection superheaters and reheaters will be used. Their surface has been divided to give necessary temperature control with minimum use of reheat attemporation and without danger of overheating reheater tubes during periods of tripout or shutdown. Control below full load will be primarily obtained by recirculation of flue gas from the economizer outlet.

Muskingum River boilers are designed for the same capacity, pressure and temperature conditions. Arrangement of superheater, reheater, economizer and air heater will be identical. However, a two-stage slag-tap furnace design will permit use of coals with low ash fusion characteristics. Primary furnace will be 56-ft wide, 15-ft deep and 71-ft high. These boilers will also be designed for full pressurized operation, and draft fan capacities and arrangement will be similar to Kanawha River units.

Condensing Equipment

Condenser is of single-pass, divided-circulation type with 90,000 sq ft of cooling surface. Storage type hotwell is provided with 1100 cu ft capacity. Design provides for condenser deaeration with standard residual oxygen guarantee of 0.03 cc per liter, although experience shows this will be considerably better.

Two circulating water pumps, each 70,000 gpm capacity, provide cooling water for condenser of each unit as well as general service water. Condensers are low enough to permit siphon operation. To reduce basement depth, circulating water pumps are located in the screen house, some distance from the plant. Pumps are vertical-type of standard dry-pit volute centrifugal design.

Water flows through the two halves of the condenser in opposite directions, and provision is made to backwash the condenser at full load by means of two special butterfly-type reversing valves, operated simultaneously by a single switch on the control panel.

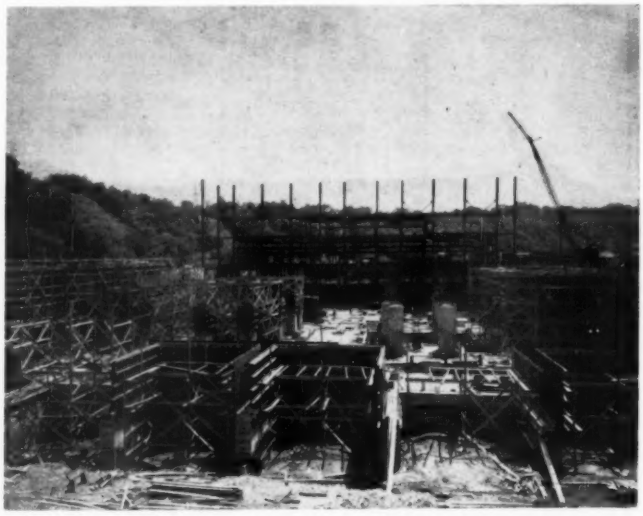
Electrical Features

Kanawha generators will be very similar to those installed at Philip Sporn and Tanners Creek Plants, though larger. The 1800-rpm double-winding low pressure unit will be rated 140,000 kva at 0.8 power factor and 0.5 lb hydrogen pressure. Short circuit ratio will be 0.8. The 3600-rpm high pressure generator will be rated 75,000 kva at 0.85 power factor and 0.5 lb hydrogen pressure, with a short circuit ratio of 0.7. At 30 lb hydrogen pressure the low pressure unit will be rated 175,000 kva at 0.8 power factor, and the high pressure at 93,000 kva at 0.85 power factor.

Shaft-driven exciters will provide excitation current, supplemented by a motor-generator set for starting up the combined generator unit. A second motor-generator set will provide emergency excitation. Voltage control for each unit will be provided by

(Continued on page 104)

Fig. 4. General view, looking east, of the main plant site at the Muskingum River Plant in July, 1952



What Is "Size Consist" Worth?

By **FRED M. REITER**
Materials Research Engineer
The Dayton Power & Light Co.

Size consist of coal may be more important to stoker operator than many other factors he knows about . . . This article takes out much of the mystery surrounding it . . . Author discusses "fines," coal sizes, buying of "tailored" coals, offers some ideas and "educated guesses" on how power plants may account for size consist in buying coal, how much they can save

IN PREVIOUS discussions of the sampling and evaluation of coals for procurement purposes (POWER ENGINEERING, February and November, 1951), this writer passing mentioned the "size consist" characteristics of coals. He was no different from many other writers who hurriedly glossed over this property of a supply of coal. This has been a mysterious subject, although it is probably of greater real importance to the stoker operator than Btu, volatile matter, fixed carbon, and other items which he constantly sees in his laboratory report. The coal buyer probably gets more complaints from his stoker operators on the excessive quantity of "fines" in the coal delivered to the boilers than on account of its chemical constituents. Too much "fines" bothers the fire, the wind pressures, air distribution, causes hanging in cars and bunkers, excessive fly ash, freezing in winter, and a multitude of other troubles.

What Are "Fines"?

But what are "fines"? What sizes limit their definition? How close could the producer, user and laboratory come in making an acceptable percentage specification of the proper proportion of the sizes in a given coal? And, first of all, what is a "given coal"? People who should know give vague answers.

William S. Major [1], in discussing factors that may reduce air pollution caused by smoke and fly ash emission, tabulated, as in Table I, the recommended standard coal sizing specifications for various types of stokers for different "given coals".

In the same issue, Carl E. Miller [2] discusses size consist and relates in some detail, various types of coal, types of stoker, burning rates, and sizes of boilers to top sizes of various "given" coals recommended. No details as to percentages of the various fractions are given. Table II gives a summarized retabulation of Miller's data to conform with the arrangement of Table I.

Both these writers seem to classify "fines" as that percentage that passes through a ¼-in. round screen. Regardless of the type of the stoker, kind and top size of coal, rate at which these different coals are burned or size or capacity of boiler, 50 per cent seems to be the maximum allowable percentage of these fines.

The author, in discussing this subject with coal vendors and users, was led to consider that 35 per cent was a good maximum figure for the "fines" in 2 × 0 nut and slack coal; and that ¼-in. screen opening was an acceptable standard for defining the top size of the fines. The ASTM Designations D311, D410 and D431 give the requirements for screen sizes and quantities of samples to be used in making laboratory screen tests. For a better understanding of the discussion that follows, Table III has been set up to list these sizes.

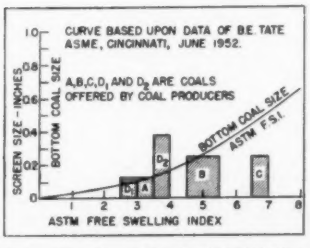

CURVE BASED UPON DATA OF B.E. TATE
ASME, CINCINNATI, JUNE 1952.
A,B,C,D1 AND D2 ARE COALS
OFFERED BY COAL PRODUCERS
BOTTOM COAL SIZE
ASTM F.S.I.
SCREEN SIZE - INCHES
BOTTOM COAL SIZE
ASTM FREE SWELLING INDEX

Fig. 1. Free swelling index related to the bottom screen sizes, developed from Tate's basic data

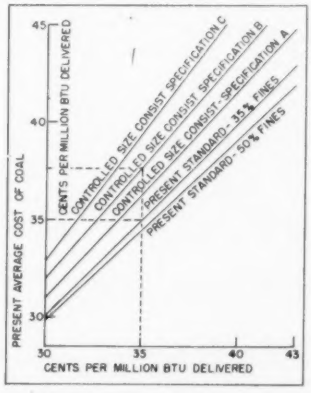

CONTROLLED SIZE CONSIST SPECIFICATION C
CONTROLLED SIZE CONSIST SPECIFICATION B
CONTROLLED SIZE CONSIST SPECIFICATION A
PRESENT STANDARD - 35% FINES
PRESENT STANDARD - 50% FINES
CENTS PER MILLION BTU DELIVERED
PRESENT AVERAGE COST OF COAL
CENTS PER MILLION BTU DELIVERED

Fig. 2. Gains in costs possible for assumed industrial power plant for various size consists of coal

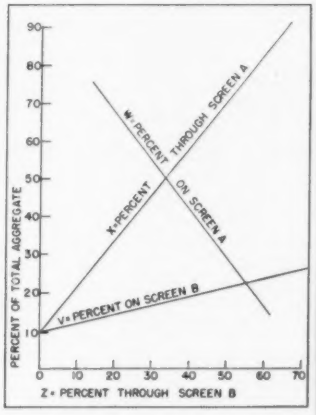

W = PERCENT THROUGH SCREEN A
X = PERCENT ON SCREEN A
V = PERCENT ON SCREEN B
PERCENT OF TOTAL AGGREGATE
Z = PERCENT THROUGH SCREEN B

Fig. 3. Curves given by James [4] to show relations between the particle sizes in pulverizer operation

Coal Producers Step Ahead

An opening now appears in the clouds that have hovered over this subject. One sees advertisements in coal magazines showing preparation plant lay-outs and screening arrangements whereby producers can separate different sizes of coal as they travel through the plant processing toward their final chutes to the cars.

[1] Formerly Development Engineer, Bituminous Coal Research, Inc.; *Utilization*, Aug. 1950.
[2] Member of Staff, Combustion Engineering-Superheater, Inc.; *Utilization*, Aug. 1950.
[3] Chief Power Plant Engineer, National Cash Register Company, Dayton, Ohio.
[4] *Power Plant Engineering*, Feb. 15, 1932.

Table I. Recommended coal sizing specifications for various stokers and various coals, as given by Major [1]

Type of Stoker	Kind of Coal	Top Size, Inches Nut and Slack	Max. Per cent Thru ¼" round mesh screen
Spreader	Eastern bituminous (Friable)	1¼ to 1½	50
Spreader	Eastern bituminous (Non-friable)	¾	50
Spreader	Midwestern bituminous	¾	50
Underfeed Single or multiple retort	Eastern bituminous (Friable)	2	50
	(Non-friable)	1 to 1¼	50
	Midwestern bituminous	1 to 1¼	50
Traveling and Chain Grate	Midwestern bituminous	1	50

Table II. Recommended coal sizing specifications for various stokers and various coals, as given by Miller [2]

Type of Stoker	Kind of Coal	Burning Rate per sq ft grate	Boiler Capacity, lb. Steam per hr.	Top Size of coal, inches nut & slack	Per cent through ¼-in. round hole screen
Spreader	Eastern bituminous (caking type)	550,000 Btu	5,000 to 200,000	1¼ to 1½	50
	Midwestern bituminous (Free burning)	550,000 Btu	5,000 to 200,000	¾	50
	Western sub-bituminous (Lignites)	550,000 Btu	5,000 to 200,000	1¼ to 1½	50
Underfeed Single Retort	Eastern bituminous (Caking type)	20 to 35 lb.	1,000 to 35,000	2	50
	Midwestern bituminous (Free burning)	20 to 30 lb.	5,000 to 30,000	1 to 1½	50
Traveling Grate	Western sub-bituminous (Lignites)	550,000 Btu	10,000 to 200,000	1	50
Chain Grate	Midwestern bituminous (Free burning)	550,000 Btu	10,000 to 200,000	1	50

Specific proposals are being offered to purchasers containing definite guaranteed proportions of various particle sizes comprising the final composite mixture shipped out. And this size-consist or sieve analysis can be supplied day after day as a uniform product.

This is a real step forward in intelligent procurement and supply of coal to the modern high capacity and high load users of coal. It can be appreciated that the coal producer is limited in his capabilities in supplying fixed percentages of screened coal sizes day after day throughout the year. His market varies widely from season to season. When screening for the supply of his winter domestic demands in a size approximating $1\frac{1}{4} \times \frac{1}{4}$, he must find a market for his $\frac{1}{4} \times 0$ carbon size coal left as his screened "fines."

When the demand for domestic screening coal slackens, he may fall back on composites like the 2-in. nut and slack to round out his production. The large producer may be able to balance his sizes among a broad market. The small producer cannot store his off sized mined coal like the farmer stores his wheat or holds his cattle or hogs for a better market. Deterioration and handling costs are too high. Cars are too precious and demurrage too costly even for a few days' relief. At the same time his labor problems become aggravated and his administrative and sales headaches become magnified.

Lucky is the large industrial or utility plant that has diversified methods of firing whereby a balanced mine output can be simultaneously shipped, enabling the coal producer to approach an equilibrium of output sizes that is so greatly desired. A combination of pulverized, spreader, underfeed or other types of firing equipment provides such a balance. Without such a balanced outlet, screened and sized coals would become classed as "premium" coals because of their costs, perhaps in balancing losses that might accrue to the residual coals not immediately in demand. As will be developed later, these screened coals become premium coals to the user at the same time, in the many benefits gained. Many large industrial users may have envied the advantage gained by the home owner who has been getting controlled size coal for his domestic stoker. These large users must be willing to pay more for such coals.

Size Consist and FSI

A paper was presented by B. E. Tate [3] at the ASME meeting in Cincinnati, June 15, 1952, that penetrated the "sonic barrier" of the problem of size consist. He defined size consist as "the proportion of each group of particles within specified size limitations, from small to large, which in the aggregate make the whole." His hypothetical example gave a really detailed breakdown of the various sized portions:

Passing through	but Remaining on	Percent
1½ inch	¾ inch	20
¾ "	¼ "	40
¼ "	10 mesh	30
10 mesh	48 "	7
48 "	—	3
Total		100

Mr. Tate then took some more mystery out of the burning processes by tying the size consist to the ASTM free swelling index number, with an example for chain grate stokers:

Free swelling index ASTM No.	Bottom screen size of coal fines
Under 3	20 mesh
3 to 4½	⅛ inch
4½ to 5½ in.	¼ "
5½ to 6½	⅓ "
above 6½	½ "

Undoubtedly such combinations of

Table III. Requirements for screen sizes and quantities of samples for laboratory screen tests, as given by ASTM. See text for author's comment on these

A. Standard or nominal sieve sizes below 2 inch:

Round holes, in inches	Square holes, wire mesh No.
2, 1½, 1, ¾, ½, ¼, ⅛	4, 8, 16, 30, 100, 200, 325

B. Comparison equivalent sizes of wire mesh Nos. and round holes in inches:

Square holes, wire mesh Nos.		Round holes, in inches
No. 4	approximately equivalent to	¼ inch
" 8	" " "	⅛ "
" 16	" " "	1/16 "
" 30	" " "	1/32 "

C. Weight of gross sample of coal required for sieve tests:

Top size of coal, round screens	Minimum weight of sample in pounds
Run-of-mine	4,000
Larger than 4 inch	4,000
Smaller than 4 "	2,000
" " 2 "	1,000
" " 1 "	500
" " ½ "	100

Table IV. Certain coal producers recommend these size consists for specific coals to be fired on underfeed stokers. See text for author's comment on them

Coal	A	B	C
ASTM free swelling index	2½ x 3½	4½ x 5½	6½ x 7
Coal seam	Winifred	Dorothy	Cedar Grove
Top size, nut and slack	2 in.	2 in.	2 in.
Size consist:			
2 x 1¼	43.7%	17.37%	20%
1¼ x ½	—	35.85%	—
1¼ x ¼	—	—	45%
1¼ x ⅛	49.6%	—	—
½ x ¼	—	21.53%	—
¼ x 0	—	25.25%	35%
⅛ x 28 mesh	6.7%	—	—
Total	100.0	100.001	100

properties of coals lead to a better understanding of the capabilities and limitations of different "given" coals. The older indefinite properties propounded in vague generalities, such as free burning, fast burning, friable, caking, may become less confusing if spelled out in terms that can be determined in a laboratory. There is an apparent relationship between particle size, rate of heating, and the resultant swelling index or rate of swelling. Mr. Tate pointed out the effect of size consist on other properties of coal which greatly affected their fitness in specific operations.

With such relationships among more specific properties becoming more clarified, it becomes possible to set up specifications for what might be truly called "tailored" coals — coals for which one would be glad to pay premium prices, coals tailored to fit the particular needs of individual boilers or plants. The term "tailored" may now take on its true significance. With many coal producers advertising controlled screen sizing, an invitation can now be extended to their field and fuel engineers, working with their counterparts in industrial plants, and to the Bituminous Coal Research organizations, to "cut the cloth" to fit individual utility and industrial equipment. The time is opportune. Cordial cooperation among these related fields of endeavor was never better.

What Can Be Done About It?

This author offers some suggestions. Figure 1 translates the basic data of Mr. Tate, developed for chain grate stokers, into a graphic chart relating free swelling index to bottom screen sizes. From such a hypothetical base, Tables V and VI have been prepared for two types of coal with free swelling index numbers of 3 and 6½. These tables list proposed size consist analyses for various nominal top coal sizes for underfeed stokers.

The curve indicates a bottom size of 1/10 in. or about 10 mesh for coals with a free swelling index number under 3. It can be noted on Table V that sizes under ⅛ in. are included in the sieve analyses in increasing percentages with diminishing top coal sizes. Such relaxation would hardly be unavoidable in actual screening practice. Even if the coal leaving the preparation plant at the mine could be held to the 10 mesh with single or even double screening, by the time the using laboratory ran the sieve analysis in the sample size demanded by ASTM requirements, breakage in handling would generate up to be indicated percentage of the tabulation of smaller coal particles. Table V makes similar allowances for the 6½ F.S.I. coals. The amount of these percentages must be determined from actual experience, both at the mines and the using plants, in order that conflicts and laboratory differences can be accommodated before rigid specifications are set up.

The curves of Fig. 2 illustrate gains in costs that might be derived by a a hypothetical industrial plant by procuring tailored coals of various size-consist specifications. Present average costs are calculated from prices, freight rates and the as received Btu values. To this must be added the cost of handling the coal in the plant from the cars to the boiler stoker and furnace. These costs must include unloading, conveying, unfreezing, hanging in cars and bunkers, stoker maintenance, and all costs chargeable to the coal burned. This probably exceeds 50 cents per ton.

Estimated new resultant costs would show the total costs per million Btu that would result from lower costs of handling, less coal handled and burned, less coal purchased, reduced maintenance costs, shut-downs, and other savings that would accrue to the use of the premium size controlled coal.

As an example, assume that the present average cost of the coal purchased by the industrial plant calculates to be 35 cents per million Btu for 13,500-Btu coal. This is determined from a price in the boilers of $9.42 per ton. If a coal meeting the requirements of Specification B were procured, at the same estimated new resultant cost of 35 cents per million Btu, it would be equivalent to 37.7 cents for the present quality of coal received, or "present average cost of coal costs". This would be calculated to be a tonnage price of $10.20 in the boiler. The plant could afford to pay 78 cents a ton more for the premium tailored coal of Specification B and come out as well as it does with current coals.

Producer and User

A coal producer that can tailor its coal to fit a plant and supply such coal day after day, as proved by laboratory tests and performance, really has a "premium" coal. The user will derive his dividends in plant costs even at higher mine prices.

Some very large coal producers have already accepted the challenge. They recommended the size consists of Table IV for specific coals to be fired on multi-retort underfeed stokers that feed up to 35 lb of coal per sq ft of grate area, producing up to 155,000 lb steam per hour, with 400F. preheated air.

These coal sizes have not yet been tried, so that no results can be reported. It is interesting to note the variation between the three coals and the previous recommendations of Tables I and II. Coals B and C use ¼ inch as the breakpoint size for fines; and offer 25 per cent and 35 per cent as maximum percentages of fines respectively. In Coal A practically all fines, coal that passes through ⅛-in. screens, is removed, only 6.7 per cent remaining.

At one nearby power plant a 12,000-Btu, 2-in. × 10 mesh coal from District No. 4 produces in excess of 500,000 lbs of steam per hour in a large boiler successfully competing with 2 × 0 high Btu District No. 8 coals. A local industrial plant uses similar coal in two different bottom sizes. The two sizes have different free swelling indexes for the different screen size limitations. These two coals are projected on the basic curve Fig. 1, as coals D_1 and D_2. The three coals tabulated above in Table IV are also located on this curve with their own respective letter, A, B, and C. These rectangular areas serve to illustrate that some relationship can exist between coal firing properties and size consists.

Joint Efforts Needed

It is not too presumptuous to suggest that coal suppliers, buyers and users approach this refinement in coal utilization jointly in an effort to develop coals *tailored to the job.*

A research engineer for a coal-using plant may ponder on the variations among the sizings proposed by the different coal producers. Of course he knows little of the problems of the coal mining, crushing and preparation operations. But he may wonder if some fairly close fixed ratios of sizes may now come out of the plants and out of a group of plants using similar crushing and processing equipment, as is encountered in the coal industry. One might expect a fairly uniform size consist in the over-all mass production.

(*Continued on page 104*)

Table V. For coal No. 1, free swelling index under 3, for underfeed stokers, taken from Tate's data [2]

COAL NO. 1

Free Swelling Index—Under 3
For Underfeed Stokers

Recommended size consist, minimum percentages
Per cent retained on given size screens
Nominal top size of coal desired, inches

Screen Sizes Mesh	Inches	½	¾	1	1¼	1½	2
30	1/30	10	5	0	0	0	0
16	1/16	20	15	10	5	5	5
8	⅛	40	30	25	20	15	10
	¼	30	40	30	30	20	20
	½	—	10	25	25	30	20
	¾	—	—	10	15	15	20
	1	—	—	—	5	10	15
	1¼	—	—	—	—	5	10

Table VI. For coal No. 2, with free swelling index 6½, for the underfeed stokers, from Tate's data [2]

COAL NO. 2

Free Swelling Index 6½
For Underfeed Stokers

Recommended size consist, minimum percentages
Per cent retained on given size screens
Nominal top size of coal desired, inches

Screen Size	½	¾	1	1¼	1½	2
48 mesh	—	0	0	0	0	0
8 "	—	5	0	0	0	0
¼	—	15	10	10	5	5
½	—	80	50	40	30	20
¾	—	—	40	35	40	40
1	—	—	—	15	20	30
1¼	—	—	—	—	5	5

Know Your

By A. LEVINE

Assistant Chief Engineer

Condenser Service & Engineering Co., Inc.

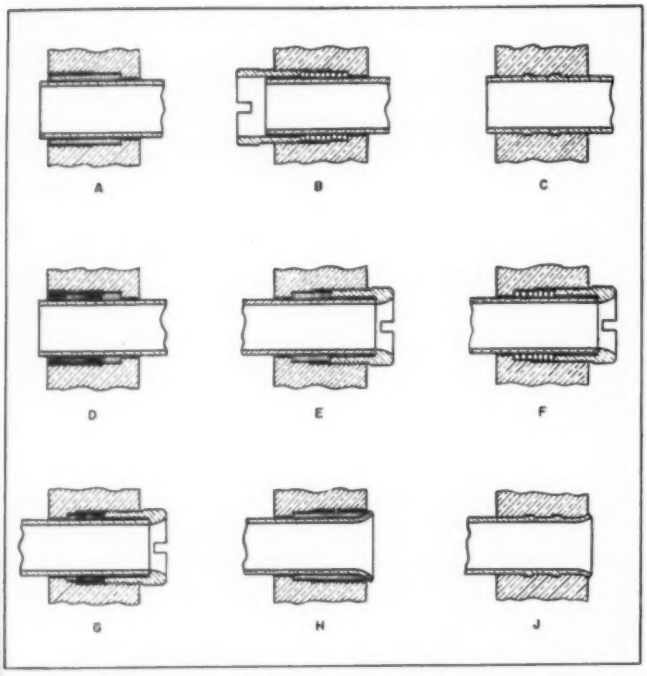


Fig. 1. A to J—Cross-sections of a number of typical expanded and packed tube joints used in power plant heat exchanger equipment. Reasons for using different types are given in the text.

A—Fibre without ferrule, outlet end. B—Corset lace with ferrule, outlet end. C—Expanded joint, outlet end. D—Fibre-metallic joint with ferrule, outlet end. E—Fibre with ferrule, inlet end. F—Corset lace with ferrule, inlet end. G—Fibre, metallic joint with ferrule, inlet end. H—Fibre joint without ferrule, inlet end. J—Expanded joint, inlet end

Fig. 2. Metallic foil packing is made by rolling up soft lead or copper foil, then partially crushing edgewise; then, in stuffing box, crushed to solid ring

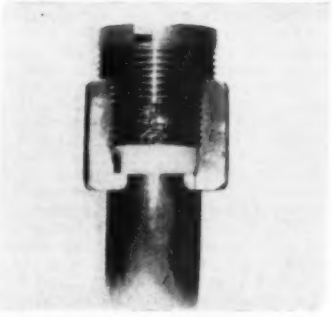


Fig. 3. Section through condenser tube joint showing single fibre metallic with ferrule, not crushed

STEAM CONDENSERS are one class of power plant heat exchanger in which use of packed tube joints has many advantages. As pointed out in an article Know Your Heat Exchanger Tube Joints, November 1952 issue, many types of feedwater heaters, lubricant coolers, vent condensers, blowdown heat reclaimers, air compressor inter-coolers and other power plant heat exchangers use fixed tube joints. Principal reasons for this are: differential expansion conditions are different, tube spacing can be closer, temperature differentials are smaller. Expanded joints are well understood. They do have some disadvantages as previously explained.

However, this article will show why, in the case of steam condensers, packed tube joints or combinations of packed and fixed joints are used.

Wide Tube Spacing: — Steam condensers must use wide tube spacing because heat removed by subcooling the condensate is not returned to the feed heating cycle but rejected to waste. Wide tube spacing allows penetration and distribution of the vapor all the way to the hotwell, so that the condensate drops through the vapor and is continuously reheated to the vapor temperature. Furthermore, wide tube spacing decreases the pressure drop through the tube bank. In condensers operating at high vacuum, this is of the utmost importance.

Since wide tube spacing is necessary from process considerations, this class of equipment can take advantage of packed joints with little change in initial cost and of much lower over-all cost if distributed over the life of the tubes.

Condensers operate between 0.5 in. and 6 in. Hg absolute, corresponding to a maximum of 141 F. At times the turbine is operated at lower vacuum (for example while cleaning one half of a divided flow unit), and rarely at atmospheric pressure (due to failure of circulator or operation of atmospheric relief valve).

Packing materials have been developed for steam condenser service to operate in fresh or salt water and at temperatures up to 212 F for long periods without deterioration.

No Tube Working: — Properly-made packed joints have the fundamental advantage of not requiring working of the tube to effect tightness. This property can be exploited in many ways. Steam condensers use large quantities of raw water for cooling. This raw water contains considerable absorbed oxygen, some of which is liberated by the turbulence created when the water flows from the water box into the tube inlets at high velocity. The gas erodes the inlet ends and this erosion is usually the cause of tube failure, although the rest of the tube may be in good condition. If the tube is expanded, it is attacked at its weakest point, where the wall is thin and the grain structure distorted. In packed tubes, the ends have not been worked and the tube end is as sound as the rest of the tube.

Longer Tube Life: — A set of packed tubes, partly worn at the inlet end due to erosion, can be removed, turned end for end and reinstalled,

Condenser Tube Joints

Steam condensers in power plant work have packed joints, sometimes combined with expanded joints, whereas most other heat exchangers use fixed joints. Why this is so, how to pack and maintain your condenser tube joints, and suggestions on how to remove tubes are given here

thus lengthening the effective life of the tubes. Another technique of lengthening tube life consists of installing tubes longer than necessary and allowing the overhang to extend into the discharge water box of each pass. When the inlet ends are eroded, the tubes are removed, the damaged section cut off and the same tube reinstalled, thereby saving a considerable investment in new tubing. There have been cases where repairs to internal damage in the condenser necessitated removal of the tubes before the tubes were worn out. If the tubes are expanded, a new set is required; if packed, the same tubes can be reused.

Fig. 4. Business end of an oyster knife, used by experienced men for collapsing expanded tube ends

Methods of Packing: — Figure 1 shows several methods of packing tube ends. Historically, corset lace was the earliest packing in extensive use. It was available in string form and a machine tool was devised to install it in the packing box. Before installation, the lace was treated with paraffin to act as a filler. Power plant operators experienced a great deal of trouble with these early joints because the machine could not handle the proper size lace, but laid in coils of small diameter string. Any heat, due to low vacuum operation, would melt the paraffin filler and leave the box leaking. Taking up on the ferrule only caused overlapping of the string and resulted in crimping of the tube.

Late in the 20's, a machine was developed that installed full size lace and at the same time squeezed it to fill the box. No filler is required and the condenser can be tested without the ferrules in place. Ferrules are added after the test to keep the lace in position. The lace is treated in boiling linseed oil before installation to preserve the material and resist rotting.

Fibre Rings: — Fibre rings have been successfully used for many years and is the cheapest of the packing techniques. While corset lace must be squeezed to fill the box for proper sealing, fibre rings seal the joint by absorbing water and swelling in place. A device is necessary to hold the fibre in place while the tube moves longitudinally. This is accomplished by machining a thread in the packing box that grips the fibre as it swells. Fibre packing can be used with or without a ferrule on the inlet end. The ferrule can serve to provide a streamlined water inlet, or the end of the tube can be belled to provide a streamlined inlet. Disadvantage of not using a ferrule on the inlet is that the bell must be machined off before the fibre can be removed preliminary to retubing. Outlet ends do not require streamlining because the turbulence occurs after the water leaves the tube.

Metallic Packing: — Metallic packing was developed for condenser work during the 20's. The packing is manufactured by rolling up soft foil and then partially crushing the ring edgewise, Fig. 2. It is available in lead or copper. The ring is placed over the tube end, set in the stuffing box and then crushed to a solid metal ring, which grips the tube and forces itself into the threads of the box. A seal is therefore made between the tube and tube sheet which also holds itself in place.

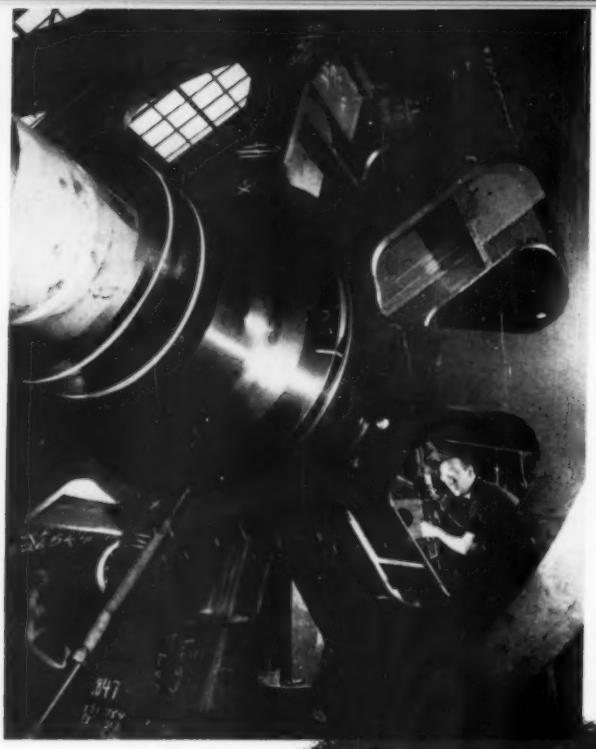
Metallic packing did not prove successful when used alone, probably because, to make the seal, the ring had to be set up so hard it crimped the tube. Metallic rings have been combined with fibre packing, the rings being lightly set up to serve as spacers for the fibres and to help keep the fibres in position. The fibre and metallic rings are installed alternately, resulting in a labyrinth type packing gland. This type of joint, shown in section in Fig. 3, is widely used and is favorably regarded in both stationary and marine power plants. The fibre metallic joint is more expensive than straight fibre, but cheaper than corset lace.

Fibre-Metallic Packing: — One other type of packing consists of a copper ring as described above but woven into this ring is asbestos string, making a one piece fibre-metallic packing. The advantage of this joint lies mainly in the fact that the asbestos will withstand high temperatures without charring or deteriorating. The copper furnishes the backing to keep the asbestos from breaking up and also, when set up, fills the box threads to hold itself in place. In certain cases, no other packing will do a satisfactory job. In combined type inter-after condensers of steam jet air ejectors, the inter-condenser normally operates under vacuum and at about 130 F while the after-condenser operates at atmospheric pressure and 212 F. Since an expansion joint cannot be installed in the shell side, packed joints must be provided to take up the difference in expansion between the two sets of tubes without straining the tubes or distorting the shell.

Further, in some plants the ejector second stage is started up for evacuation purposes before condensate is available for the inter-after condenser. In this case, the packing is subjected to high temperatures, especially in the newer plants using high-pressure, high-temperature steam for the ejectors. Fibre or corset lace would dry out and burn, and lead-foil metallic packing becomes soft and loose in the joint under these conditions.

Combining Expanded and Packed Joints: — A very common practice is to combine expanded and packed joints. The inlet tube end is expanded and the outlet end is packed. In this way, differential expansion is allowed and streamlining of the inlet end is easily accomplished by belling the tube, without the necessity of ferrules. None of the advantages of lengthened tube life can be expected

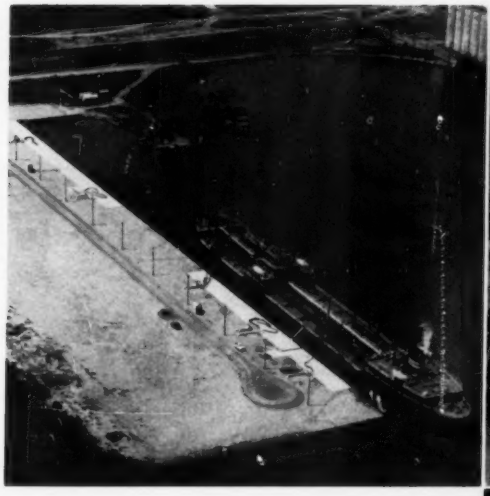
(*Continued on page 106*)

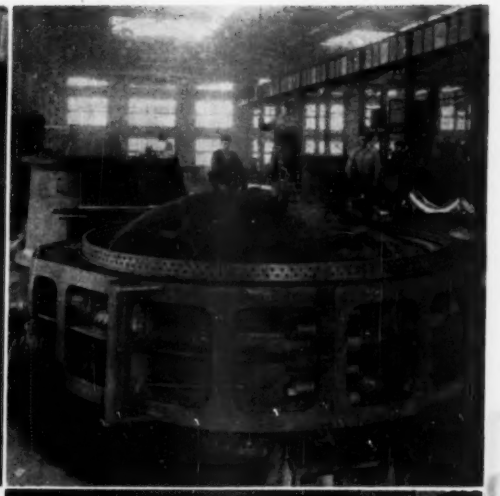


High-speed precision drill easily bores hole through the 3½ in.-thick flange of this generator shaft at General Electric. The rotor weighs 110 tons and is for a 16,667 kva hydro-generator

Power Engineering NEWS REEL

Bokaro thermal power plant, now being constructed near the Damodar River in India. Engineers and constructors: Kuljian Corp., Phila., Pa. See Oct and Nov 1951 issues of POWER ENGINEERING for details





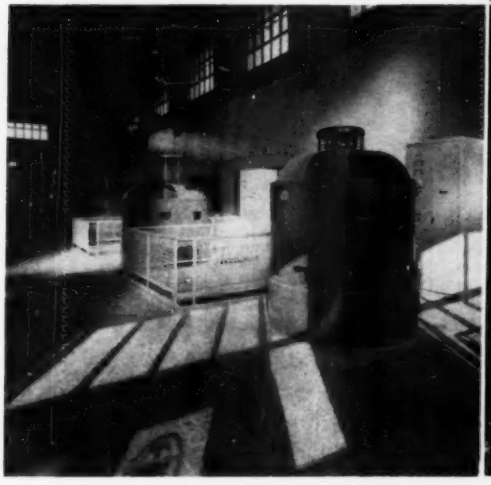
Above—Oil is pumped from the fields in Alberta, Canada, to this loading dock in Superior, Wis. From here it is to be shipped across the Great Lakes

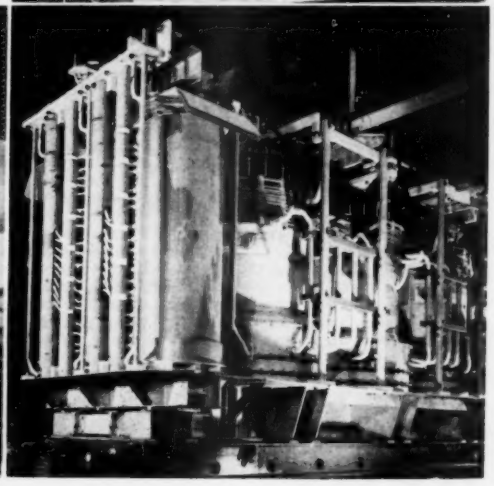
Above right—Assembling and inspecting a 17-ft butterfly valve in the Baldwin-Lima-Hamilton Corp. shop before parts are shipped to customer

Right—General Electric 20,000-kw turbine-generator set for the Kaiser Aluminum & Chemical Corp. This set will help supply power for a pot line

Below right—An internal view of the 156,000-kva autotransformer, largest in the world in capacity and physical size, built by General Electric Co.

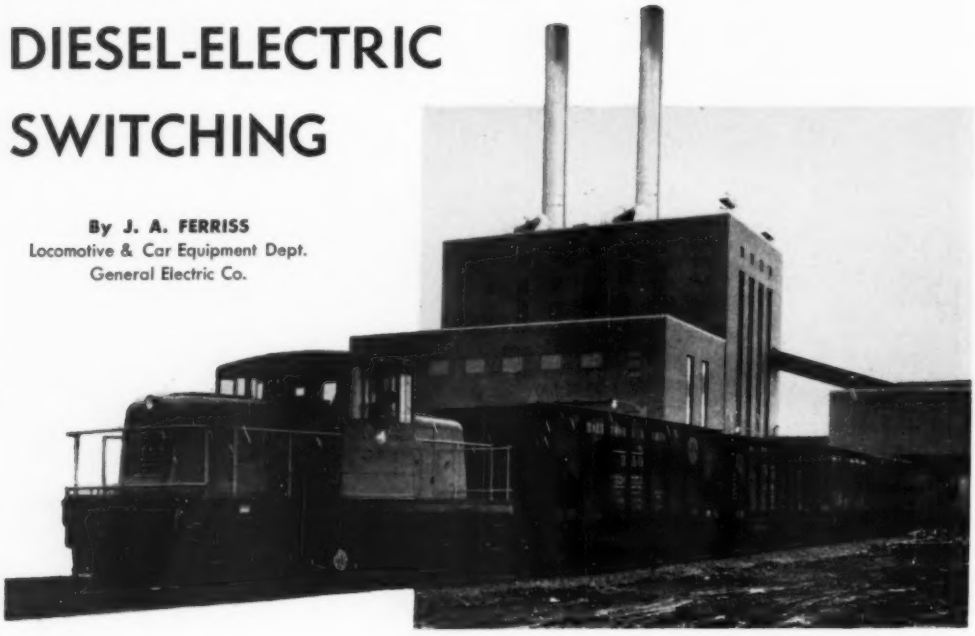
Below—Motors for the six main pumps in the Owl's Head sewage treatment plant. The vertical centrifugal pumps are in pits at self-priming level





Utilities Save With DIESEL-ELECTRIC SWITCHING

By J. A. FERRISS
Locomotive & Car Equipment Dept.
General Electric Co.



THE SAME EFFICIENT diesel-electric motive power which is serving railroads so well is also finding acceptance in steam-electric generating stations. First units to be placed in power station work were purchased in 1942. Ten years later, over 70 locomotives are operating on the properties of approximately 40 different public utility companies.

These locomotives range in size from 25 to 95 tons, and from 150 to 660 hp. They represent a standardized line of units specially designed and built for industrial switching. Because a maximum speed of 20 to 30 mph is adequate for such service, economical double-reduction geared traction motors are used on these locomotives. Maximum use is made of welding in their manufacture, resulting in exceptionally sturdy construction. Being specifically designed for switching duty, they involve a considerably lower capital investment than a similar locomotive for railroad service; yet, their design and characteristics suit them ideally to industrial switching. Since they meet ICC requirements, they can be used on railroad property where necessary.

Principal Characteristics

Diesel-electrics, of course, require no fire which eliminates hostling, fire cleaning and tending operations. They start at the push of a button. Another characteristic is high availability. Diesel-electrics are ready for call more than 90 per cent of the time. In many cases, a single diesel-electric unit can handle an assignment which would require two steam locomotives.

Unlike many steam locomotives, the diesel-electric does not require a tender. For this reason, its entire weight is on the driving wheels which helps to increase pulling power of the locomotive. Neither is it necessary to haul extra weight which does not contribute to the locomotive tractive effort. Moreover, the diesel-electric is able to pull more load per ton of weight on drivers. This is because electric traction motors apply power smoothly to the wheels, whereas power applied by the steam engine is constantly varying for each position of the driving rods. Therefore, wheels of the diesel-electric are less likely to slip, especially when working near the limit of adhesion.

In the past, the steam storage locomotive has found some application in power plant service. It was less costly than a conventional steam locomotive with a firebox and boiler. It usually had all of its weight on drivers and did not need a tender. A steam charging connection was provided at the power plant boiler, and the locomotive spent from 30 to 40 min out of every 2 to 3 hr replenishing its supply of steam. Mounting labor costs have made it too expensive to have the crew stand around idle while the locomotive is charging. For this and other reasons the steam storage locomotive has lost favor.

Savings For Utilities

In the public utility field, as well as in other industries, the diesel-electric locomotive has demonstrated its economy and reliability. Like its big brother on the railroads, it is taking an increasing share of the load and turning in impressive records of economy and performance. One large eastern utility reports that its 65-ton diesel-electric used only 16 gal of fuel oil daily, instead of the ton and a half of coal consumed by the steam locomotive formerly used. Another steam-electric generating station has reduced its fuel and maintenance costs by 91 per cent, and has paid for its diesel-electric out of savings in less than 4 years.

Correction Note:— AEC Power Project

THE ITEM under this title, page 88, November issue, should have stated that two steam electric generating plants were planned in the Ohio River Valley for a total installed capacity of 2,200,000 kw and would supply most of it to AEC's new uranium plant.

Power Engineering's

PRACTICAL ENGINEER and ELECTRICIAN SECTION

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How to Figure Piping Offsets

By THOMAS TRAIL

WHERE IT IS NECESSARY to employ angle pipe fittings and diagonal runs of pipe, reference to Table I will quickly furnish the diagonal distance between fitting centers, as well as the distance between fitting centers, to which the straight pipe run will be projected.

Figure 1 gives an example of how the chart is employed. First the center-to-center offset distance between the two straight runs of pipe (a) is determined. In the example this is 2 ft 7 1/2 in. Referring to Table I column heading, 45 deg fittings, note the column marked, diagonal length. Follow down this column to the line marked, 2 ft. The diagonal length for 2 ft is given as 2 ft 9 13/16 in.

Now again referring to the table column marked, diagonal length, follow down to the line marked, 7 in. The diagonal length for 7 in. is given as 9 7/8 in.

Again referring to the same table column, follow down to the line marked, 1/2 in. The diagonal length for 1/2 inch is given as 11/16 in.

Now adding together these diagonal lengths for 2 ft, 7 in. and 1/2 in. (2 ft 9 13/16 in. + 9 7/8 in. + 11/16 in.) a total diagonal length of 3 ft 8 1/2 in., as shown at (b) in Fig. 1, is obtained. This is the distance between the centers of the two 45 deg fittings.

In order to determine the actual length to cut the diagonal pipe, first measure the distance between the center of one of the fittings to be used and its face, as shown in Fig. 1A. This dimension will vary with the size and type of fitting employed. Since the

Fig. 1. An example of how figures in Table I are to be used for measuring diagonal runs of pipe

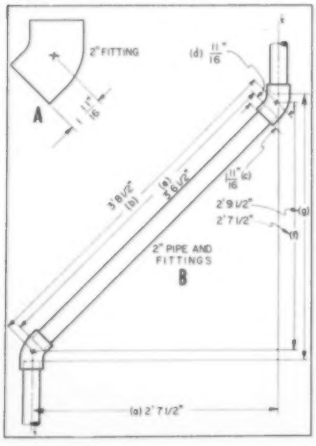


Table I. Diagonal distances and projection length for runs of pipe using 45, 60, and 22½ deg fittings

Feet	45 Degree Fittings		60 Degree Fittings		22½ Degree Fittings	
	Diagonal Length	Projection	Diagonal Length	Projection	Diagonal Length	Projection
1	1 ft. 4 15/16 in.	1 ft. 0 in.	1 ft. 1 13/16 in.	6 13/16 in.	2 ft. 7 5/16 in.	2 ft. 4 15/16 in.
2	2- 9 13/16	2-0	2- 3 5/8	1- 1 11/16	5- 2 5/8	4- 9 13/16
3	4- 2 7/8	3-0	3- 5 3/8	1- 8 1/2	7- 9 15/16	7- 2 3/4
4	5- 7 7/8	4-0	4- 7 1/16	2- 3 3/8	10- 5 1/4	9- 7 11/16
5	7- 0 13/16	5-0	5- 9	2-10 3/16	13- 0 5/8	12- 0 5/8
6	8- 5 13/16	6-0	6-10 13/16	3- 5 1/16	15- 7 15/16	14- 5 1/2
7	9-10 3/4	7-0	8- 0 5/8	3-11 7/8	18- 3 1/4	16-10 7/16
8	11- 3 3/4	8-0	9- 2 3/8	4- 6 3/4	20-10 9/16	19- 3 3/8
9	12- 8 11/16	9-0	10- 4 3/16	5- 1 5/16	23- 5 7/8	21- 8 1/4
10	14- 1 11/16	10-0	11- 6	5- 8 3/8	26- 1 1/16	24- 1 3/16
Inches						
1	1 7/16 in.	1 in.	1 1/8 in.	5/16 in.	2 5/8 in.	2 7/16 in.
2	2 11/16	2	2 5/16	1 1/8	5 1/4	4 13/16
3	4 1/4	3	3 7/16	1 11/16	7 13/16	7 1/4
4	5 5/8	4	4 3/8	2 1/4	10 7/16	9 5/8
5	7 1/16	5	5 3/4	2 7/8	1'- 1 1/16	12 1/16
6	8 1/2	6	6 7/8	3 7/16	1'- 3 11/16	1'-2 7/16
7	9 7/8	7	8 1/16	4	1'- 6 1/4	1'-4 7/8
8	11 5/16	8	9 3/16	4 5/16	1'- 8 7/8	1'-7 1/4
9	12 3/4	9	10 3/8	5 1/8	1'-11 1/2	1'-9 11/16
10	1'-2 1/8	10	11 1/2	5 11/16	2'-2 1/8	2'-0 1/8
11	1'-3 5/16	11	12 5/8	6 1/4	2'-4 11/16	2'-2 1/2
Inch						
1/16	3/32 in.	1/16 in.	1/16 in.	1/16 in.	3/16 in.	1/8 in.
1/8	3/16	1/8	1/8	1/16	5/16	5/16
3/16	1/4	3/16	3/16	1/8	1/2	7/16
1/4	3/8	1/4	5/16	1/8	5/8	5/8
5/16	7/16	5/16	3/8	3/16	13/16	3/4
3/8	1/2	3/8	7/16	3/16	1	7/8
7/16	5/8	7/16	1/2	1/4	1 1/8	1 1/16
1/2	11/16	1/2	9/16	5/16	1 5/16	1 3/16
9/16	13/16	9/16	5/8	3/16	1 7/16	1 3/8
5/8	7/8	5/8	3/4	3/8	1 5/8	1 1/2
11/16	1	11/16	13/16	3/8	1 13/16	1 11/16
3/4	1 1/16	3/4	7/8	7/16	1 15/16	1 13/16
13/16	1 1/8	13/16	15/16	7/16	2 1/8	1 15/16
7/8	1 1/4	7/8	1	1/2	2 5/16	2 1/8
15/16	1 5/16	15/16	1 1/16	9/16	2 7/16	2 1/4

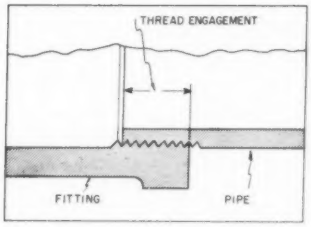


Fig. 2. This is how effective thread length is measured. Measurement is made from flange to bottom thread

Table II. Effective thread engagement in inches for different size fittings ranging from ⅛ in. to 12 in.

THREAD ENGAGEMENT (Inches)									
Pipe Size	⅛ in.	¼ in.	⅜ in.	½ in.	¾ in.	1 in.	1¼ in.	1½ in.	2 in.
Thread Engagement	¼	⅜	⅜	½	9/16	11/16	11/16	11/16	11/16
Pipe Size	2½	3	3½	4	5	6	8	10	12
Thread Engagement	13/16	1	1⅛	1⅛	1¼	1 3/16	1 7/16	1⅝	1¾

pipe and fittings shown in Fig. 1 are 2 in. size, the fittings being made of malleable iron, the center to face dimension of each fitting (c) is $1^{11}/_{16}$ in. And since two identical fittings are employed, multiply $1^{11}/_{16}$ in. by 2 and a total of $3^{3}/_{8}$ in. will be obtained.

Next locate the effective thread length for the size pipe being used (2 in. in the example in Fig. 1) in Table II. For 2 in. pipe this is $^{11}/_{16}$ in., as shown at (d) in Fig. 1. Doubling this dimension $1^{3}/_{8}$ in. is obtained. This is the total length of thread on both ends of the pipe.

Now subtract this $1^{3}/_{8}$ in. total from the $3^{3}/_{8}$ in. total of the center to face dimensions of the fittings. The result is 2 in.

Finally subtract this 2 in. from the distance between centers of the 45 deg fittings (3 ft $8^{1}/_{2}$ in.) and 3 ft $6^{1}/_{2}$ in. is the result. This is the actual length of the diagonal pipe ((e) in Fig. 1) required.

To determine how far the offset run of pipe will project the straight run, refer to Table I again and note the dimensions given, in the column marked, projection, under the heading, 45 deg fittings, for an offset distance of 2 ft + 7 in. + $^{1}/_{2}$ in. These will be found to be 2 ft 7 in. and $^{1}/_{2}$ in. respectively. (In the case of 45 deg fittings, it will be noted that the projection distance is always equal to the offset distance.) When added together, the projection distances total 2 ft $7^{1}/_{2}$ in., the center-to-center distance between the 45 deg fittings in the direction of the straight run of pipe, as shown at (f) in Fig. 1.

To find the actual distance the straight run of pipe has been projected, we must double the center to face dimension of the 45 deg fittings ($1^{11}/_{16}$ in. $\times$ 2 = $3^{3}/_{8}$ in.); double the effective thread length of the pipe ends ($^{11}/_{16}$ in. $\times$ 2 = $1^{3}/_{8}$ in.); and then subtract the latter from the former, obtaining 2 in. as the answer. Adding this to the projected distance of the straight pipe run between fitting centers ((f) in Fig. 1) gives 2 ft $9^{1}/_{2}$ in., the actual total projection of the straight pipe run ((g) in Fig. 1) produced by the diagonal offset pipe run shown in Fig. 1.

When using Table I, offset multiples of 10 feet, such as 20, 30, 40 etc., require only that the diagonal length or projection distance given for 10 feet be multiplied by the number of times 10 divides equally into the offset distance, to obtain the diagonal length or projection distance.

Equipment Good— Air Conditions Bad

How Were They Cured?

By C. T. BAKER

In a 20-ton air-conditioning plant for comfort conditioning, the contractor had installed good equipment, but it didn't give the cooling or ventilation required. Author found water pump piping too small, coil frosting, by-pass damper open, fan speed wrong. When fixed, system OK

A RATHER PROMINENT country club installed a 20-ton air conditioning plant in 1951 to furnish comfort cooling for the grill room. From the beginning, results were very unsatisfactory, for inside temperatures and humidities were too high for comfort, and kicks from the members made the manager's life very unpleasant.

The sub-contractor's quotation to the prime contractor, a heating and plumbing concern, is an excellent example of brevity, as follows:

"We are pleased to name you a price of $——— for furnishing and installing the cooling cycle for the above named club. We propose to furnish and install the following:

Condensing unit (20 hp)
Air unit
Freon mains and specialties
Freon and oil
Two-speed starter for 2-speed motor, (fan)
Starter for compressor motor.

We have not included the by-pass damper or filters since they are shown in the duct work. We have not included any insulation, condensing water pump or condensing water piping."

You will notice that no mention of capacities is made, other than the size of the compressor motor — 20 hp — which, on comfort cooling work, would be ample for 20-tons refrigerating capacity.

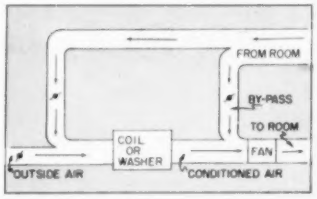


Fig. 1. Diagram of the by-pass damper system

During the writer's investigation, however, it developed that the refrigeration plant contractor had done a good job of installing his equipment and that the 20-ton compressor was more than ample to handle peak loads.

A Look Behind the Scenes

The first of the various things discovered, that were preventing the plant from producing satisfactory results, was the short cycling of the compressor. Only a few minutes of running time was possible before the suction pressure would be diminished to the point where the low pressure cut-out would cause the machine to stop. This was found to be due to an insufficient charge of Freon 12. However, after the system had been fully charged, a new problem arose; the high pressure cut-out would not permit the compressor to operate longer than 10 to 15 minutes at a time because of excessive condensing pressure.

An investigation of the condensing

water supply disclosed that the water came from a lake not far from the club and that it was pumped through the multi-pass shell and tube Freon condenser by a rotary pump of undetermined capacity and pumping head. The size of both the suction inlet and the discharge outlet of the pump, which was $2\frac{1}{2}$ in. diameter, indicated, however, that the builder had had in mind operating with a $2\frac{1}{2}$ in. suction and discharge pipe and not the $1\frac{1}{2}$ in. diameter being used.

A check on the motor input showed that it was operating 45 per cent overloaded, and further, that the pump was working against a discharge head of 81 feet. Under these conditions, the pump was giving a total of 30 gpm, by actual measurement. Since the minimum amount of condensing water that would assure proper performance of a 20-ton plant, at the 88 F temperature of the lake water, is 60 gpm, it was not difficult to understand why the high pressure cut-out would stop the compressor with only half enough water being delivered to the condenser.

As a temporary measure and to facilitate comfort cooling for the remainder of the season, a $2\frac{1}{2}$ in. suction line between the pump and the lake was installed to replace the original $1\frac{1}{2}$ in. line. A larger foot valve also helped matters. Although the greater part of the discharge line was located beneath the floor of the grill room, we were able to replace about seventy feet underground outside between the pump and the building, with $2\frac{1}{2}$ in. pipe. These changes, along with the use of some city water, greatly improved the operation of the system during the rest of the summer.

At the close of the season the $2\frac{1}{2}$ in. line was re-routed and run overhead in a room adjoining the grill room. The return line from the condenser to the lake was increased to $2\frac{1}{2}$ in., except the underground section which was changed to 4 in. terra cotta.

A comparison of the before and after results is very interesting. For example, the pump output was increased from 30 to 60 gpm, or 3 gpm per ton against $1\frac{1}{2}$ gpm per ton.

The pumping head was reduced from 81 feet to 28 feet, a gain of 53 feet. This also cured the overloading of the pump motor.

Temperature rise in the water passing through the condenser was reduced from 14 to 8 degrees, while the water to the condenser was increased from 30 to 60 gpm. This resulted in not only decidedly better cooling efficiency but a reduction in compressor horse-power due to a decrease of 25 lb per sq in. in condensing pressure.

Judging from the clouds of cigar and cigarette smoke that hung above the tables in the grill room, it was deduced that more outside air was required. A check on the fan showed that it was handling 3440 cfm of return air and 475 cfm of outside air with a fan speed of 1000 rpm. As the fan motor was under-loaded, a larger pulley was installed to bring its speed up to 1275 rpm, which still left a safe margin of under-load on the motor. This change in fan speed resulted in an increase from 475 to 1025 cfm, or an additional 550 cfm of outside air, and from 3440 to 4220 cfm, or 780 cfm more return air.

Air Cooling Unit Frosting

Frosting-over of the air cooling unit was another problem in the plant. A by-pass had been provided in the plenum to permit air to by-pass a heating coil that supplied heat during the winter months. Because of reduced demands for heat at the end of the season, this by-pass was usually left fully open. Failure to close this damper when the air conditioning plant was placed in operation resulted in a reduction of the load on the cooling coil and a reduction in coil evaporating temperature below the freezing point of moisture with consequent frost and ice formation on the coil that was incredible. However, closing of the by-pass damper promptly cleared up this trouble.

Separators Are Required In Superheater Installations, Too

By MARION A. JENSEN

FIGURES 1 and 2 give mute testimony to the fact that the installation of superheaters in a boiler does not eliminate the necessity for protection of the prime movers against carryover.

In this particular case where a new plant was being constructed, the management, in view of the fact that the installation of superheaters had been sold on the merits of production of dry steam and feedwater regulators on the merits of the maintenance of a uniform water level, regarded the engineers' request for separators as a superfluous appendage, and turned it down flat.

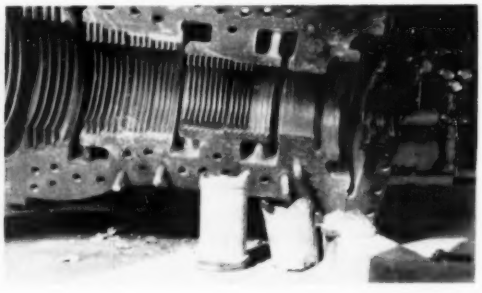
Let's see what happened? In less than two months following the plant's start the feedwater regulator on one of the boilers stuck in the open position. The boiler operator, while he should have, according to management's viewpoint, noticed the incident, but being human, and having a number of other duties, did not notice that the boiler completely filled with water. The engineer, however, did notice it, but alas, too late!

The plant was out of operation some 30 days while the turbine received a complete new set of blading. The cost? Well, about twenty times the cost of what the engineer wanted in the outset.

But it won't happen again at that place. Oh, yes, the engineer was permitted to install separators that will handle 100 per cent carryover. And just in case the boiler operator should forget — there are now safety alarm columns on each boiler.

Fig. 1. Burst strainer and 4 rows of the high pressure turbine blading missing

Fig. 2. Wrecked intermediate stationary blading of turbine shown in Fig. 1



Basic Power Plant FIGURING

A Review for Old-Timers—
A Must for Young-Timers

By WILLIAM H. ENGELMAN
Mechanical Engineer
Cleveland, Ohio

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How to Figure Size and Mechanical Design of Natural-Draft Chimneys

THE REASON for building a chimney for a steam power plant is to produce the natural draft required for burning the fuel and to operate the boiler efficiently, and for discharging the flue gases high in air as they are formed. This draft is produced because the chimney gases are hotter and therefore lighter than the outside air. Thus the chimney gases escape by rising to the top and are replaced by fresh air entering under the grates. Difference in temperature between the hot gases inside the chimney and the outside air produces the flow of air necessary for burning the fuel. (When forced or induced draft fans are used, the chimney is only a discharge pipe.)

Height and diameter of a chimney are governed by numerous factors. It must be of ample size to carry off the products of combustion and it must be high enough to produce the needed draft.

Here we shall consider only these factors and not concern ourselves with such things as the architectural symmetry of the community. We are only interested in the results obtained in a boiler plant. Before a chimney can be chosen the following information must be available:

Location above sea level, feet _____
Fuel burned, coal, oil, gas, wood, etc. _____
Steam requirements, pounds per hour, maximum _____
Flue-gas temperature, degrees F _____
Flue-gas velocity, feet per second _____
Soil bearing capacity, tons per square foot _____
Depth of foundation, frost line, feet _____

Let us now consider the design of a chimney to serve four boilers capable of supplying a maximum of 32,000 lb of steam per hour each over a 4-hr period (4-hr peak). Once the peak load has been determined, all the other necessary data can readily be obtained from the boiler manufacturer.

Typical example of data submitted in an actual bid:

Steam generated, pounds per hour, 4 hour peak	32,000
Draft loss through boiler, in. wg	0.57
Draft loss through damper, in. wg	0.09
Air resistance through stoker, in. wg	0.15
CO_2 leaving boiler, per cent	13.5
Excess air, per cent	37.0
Coal fired, pounds per hour	3,470
Heat release, Btu per cubic foot of furnace volume	43,900
Flue-gas temperature, boiler outlet, F	600
Flue-gas, pounds per hour	44,900
Flue-gas, cubic feet per minute	18,600
Boiler heating surface, square feet	4,300
Boiler rating, per cent	222
Overall efficiency, per cent	75.0

The stack must provide sufficient draft to overcome the sum of all the draft losses. The losses within the boiler are given in the figures submitted by the bidder. There are additional losses due to friction and bends in the breeching and changes of direction of gases. Over a period of many years of calculations, the losses have been tabulated and these are accepted throughout the field today. A well known chimney builder gives the following: breeching, 0.10 in. wg (inches water gage) per 100 ft; right-angle bend, 0.05 in. wg.

In the case in question, we may consider the losses as follows:—

Boiler	0.57 In. wg
Damper	0.09
Stoker	0.15
Two right angle bends	0.10
Breeching	0.07
Total	0.98 In. wg

The draft a chimney will develop is affected by the temperature of the flue-gases. Draft is a function of the difference in weight of the column of gas in the stack and the weight of a column of air of equal height without the stack. Obviously, there will be a loss in temperature from the boiler outlet until the gases leave the stack. This must be considered, and the average temperature should be the value used.

The 1949 ASH&VE Guide, 27th Ed., page 401, eq 5 (29th Ed., page 382, eq 6) gives the average or effective temperature:—

$$T_c = \frac{3.13T_i\left[\left(\frac{H_c}{3}\right)^{0.96} - 1\right]}{H_c - 3}$$

where:—T_i = absolute temperature of gas, F, in breeching at stack entrance.
H_c = Height of stack in feet from center line of breeching to top.
T_c = Average temperature of the gases in chimney, degrees F abs.

Inserting values: $T_i = 600 + 460 = 1060$
$H_c = 200$ feet (calculation for this item given later).

$$T_c = \frac{3.13 \times 1060\left[\left(\frac{200}{3}\right)^{0.96} - 1\right]}{200 - 3} = \frac{3317.8 \times 55.5}{197} = 935 \text{ F abs.}$$

and $935 - 460 = 475$ F average temperature.

From Kent, volume 2, 11th Ed., page 6–105, by interpolation, a factor of 0.785 will give an average temperature of 472 F.

There are only slight differences in the results obtained by different means to select the height of chimneys. The ASH&VE Guide gives:

$$H = \frac{D_i}{2.96\,B_o\left(\frac{W_o}{T_o} - \frac{w_c}{T_c}\right) - \frac{0.184f\,W_c B_o V^2}{T_c D}}$$

$$D = 0.288\sqrt{\frac{WT_c}{B_o W_c V}}$$

Where:—
H = Height of chimney, feet.
D = Diameter at top of chimney, inside, feet.
D_i = Total draft required, inches water gage.
W_o = Density of air at zero F and atm. press.
W_c = Density of flue-gas at zero F atm. press.
T_o = Temp. of atmosphere, F absolute.
T_c = Temp. of flue-gas, F absolute.
f = Coefficient of friction (0.016).
B_o = Barometric pressure, inches Hg.
V = Velocity of gases at top of chimney.
W = Weight of flue-gases, pounds per second.

The ASH&VE Guide, 27th Ed., page 403 (8) gives an equation for the economical velocity of chimney gases:

$$V = \left[\frac{0.772\,T_c\left(\frac{W_o}{T_o} - \frac{W_c}{T_c}\right)\sqrt{\frac{WT_c}{B_o W_c}}}{FW_c}\right]^{0.4}$$

$$= \left[\frac{0.772 \times 935\left(\frac{0.0863}{520} - \frac{0.09}{935}\right)\sqrt{\frac{50 \times 935}{29.92 \times 0.09}}}{0.016 \times 0.09}\right]^{0.4}$$

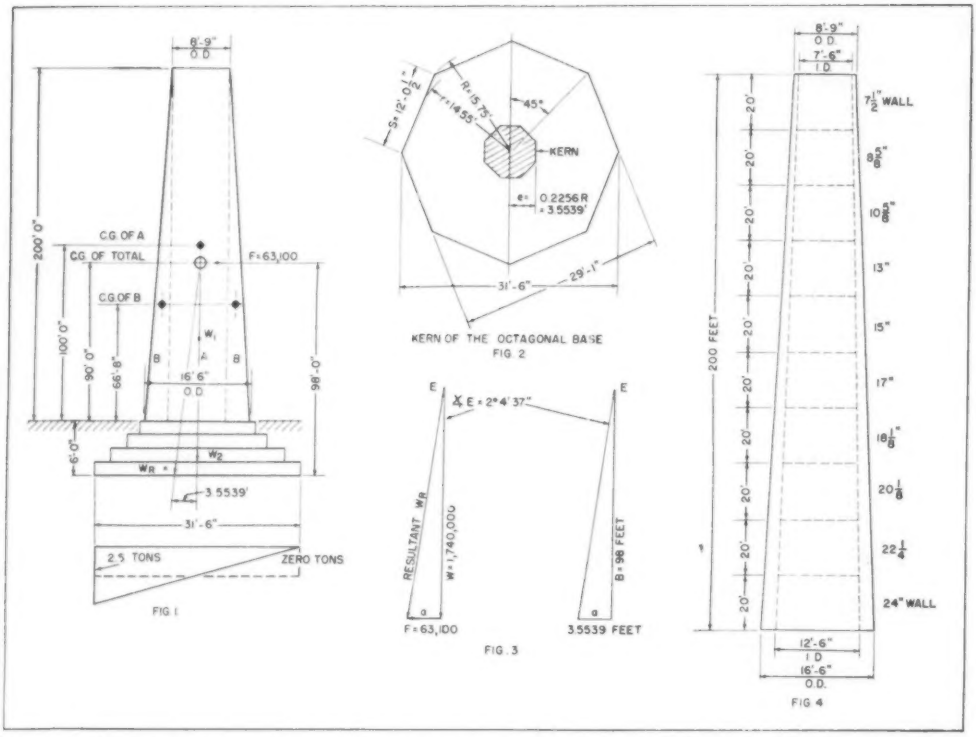
$$= \left[\frac{722(0.0001652 - 0.0000963)\sqrt{17{,}350}}{0.00144}\right]^{0.4}$$

$$= 29.3 \text{ fps gas velocity; use 30 fps.}$$

then $$D = 0.288\sqrt{\frac{50 \times 935}{29.92 \times 0.09 \times 29.3}}$$

$$= 0.288 \times \sqrt{599} = 7.05 \text{ ft dia.}$$

It is an accepted fact that effective diameter of the chimney is not the full diameter, but that there is a dead air space of about 2 in. In the case of a circular chimney the effective diameter would be 4 in. less than the actual diameter. Therefore the actual diameter to be selected would be approximately 7.5 ft.



Figures 1–4. Details of chimney given in numerical example, to show factors that must be taken into account in mechanical design after the dimensions are figured

Fig. 1. Locations of centers of gravity and moments. Fig. 2. Dimensions and location of kern of octagonal chimney base. Fig. 3. Force diagram for vertical and horizontal forces on chimney. Fig. 4. Wall thickness and other physical dimensions of the chimney for which the size and mechanical design figuring are given in the examples which are shown here.

Calculating for the required height H and inserting actual values, we have:

$$H = 0.98 \div \left[2.96 \times 29.92\,(0.0001652 - 0.0000963) - \frac{0.184 \times 0.016 \times 0.09 \times 29.92 \times 30^2}{935 \times 7.5} \right]$$

$$= \frac{0.98}{88.56 \times 0.0000689 - 0.0017} = 193 \text{ ft}$$

For comparison, Alphons Custodis Chimney Construction Co. gives the following:

$$H = \frac{MTD}{\left(\frac{7.64}{T_o} - \frac{7.95}{T_i}\right)}, \text{ where MTD} = \frac{D_r}{0.8} = \frac{0.98}{0.8} = 1.225$$

$$H = \frac{1.225}{\left(\frac{7.64}{520} - \frac{7.95}{935}\right)} = \frac{1.225}{0.00620} = 197 \text{ ft}$$

The two values obtained are so close that either may be selected. To this value should be added about 3 ft to center line of grate, it would make the chimney 200 ft high.

We have now:

1. The chimney height shall be 200 ft.
2. The inside diameter at the top 7.5 ft.
3. The gas velocity will be about 30 fps.
4. The total draft supplied will be 1.225 In. wg.
5. Average temperature of chimney gases will be 475 F.
6. Diameter of chimney at base: 16'6"
7. Weight of chimney and lining: 600 tons
8. Weight of concrete foundation: 270 tons
9. Total vertical load on soil: 870 tons
10. Allowable soil pressure per sq ft: 2.5 tons

We can now determine what forces the chimney will be subjected to. Winds produce pressures according to their velocity. These pressures should be calculated as if they are exerted over the entire height of the chimney, though such will not be the case, as stratification takes place and only a portion of the chimney will be affected. If we compute these forces in this manner, a factor of safety has been added to the calculations.

By taking a cross-section at the diameter of the chimney from top to bottom, we have the projected area exposed to the effect of the wind. It is reasonable to consider a maximum wind velocity of 100 mi per hour, this equals an average pressure of approximately 25 lb per sq ft on a round chimney. Customary practice is to use from 20 to 25 lb per sq ft, depending upon the chimney exposure and the locality; 25 lb per sq ft has been assumed in this problem.

Referring to Fig. 1, the projected area of the chimney consists of the rectangle A plus the 2 triangles B.

Area of A is 200 × 8.75	1,750 sq ft.
Area of 2 B is 2 × 3.875 × 100	775 sq ft.
Total projected area	2,525 sq ft.
Also: 0.5(8.75 + 16.5) × 200	2,525 sq ft.
Moment of A is 1,750 × 100	175,000
Moment of 2 B is 775 × 66.67	51,700
	226,700

Center of gravity is $\frac{226,700}{2,525} = 90$ ft above the base

The horizontal force F applied at the center of gravity equals the projected area in square feet times the pressure of 25 lb per sq ft.

F is 2,525 × 25 = 63,100 lb or 31.55 tons.

The moment at the base of the chimney shaft is:

63,100 × 90 = 5,679,000 ft-lb or 2,839.5 ft-tons.

The vertical load W consists of:

W_1 is the chimney at	600 tons or 1,200,000 lb
W_2 is the foundation at	270 tons or 540,000 lb
W is	870 tons or 1,740,000 lb

The resultant W_r can now be calculated from the components F and W. These components act at right angle to each other and the sum of their squares is equal to the square of the hypothenuse, which is W_r. The force F can be applied at a, see Fig. 2. We then have:

$W_r = \sqrt{W^2 + F^2} = \sqrt{1{,}740{,}000^2 + 63{,}100^2} = 1{,}741{,}000$ lb or 870.5 tons.

Solving for angle E in the force plygon, Fig. 3,

Tan E = F ÷ W = 63,100 ÷ 1,740,000 = 0.036265; the angle is 2 deg 4 min 37 sec

a is b × tan E = 98 × 0.036265 = 3.5539 ft, called e. which is the distance from centerline where W_r cuts the base.

This distance of 3.5539 feet must fall inside the *kern* of the base.

The 5th edition of Marks Mechanical Engineers Handbook gives the following definition on page 464:

"The *kern* is the area around the center of gravity of a cross-section within which any load applied will produce stress of only one sign throughout the entire cross-section. Outside the *kern*, a load produces stresses of different signs. Figure 2 shows the *kern* for the octagonal base of a chimney together with other dimensions for the full layout."

e is 0.2256 R, then R is e ÷ 0.2256 = 3.5539 ÷ 0.2256 = 15.75 ft or 15 ft 9 in.

By using the values for *Regular Polygons*, as given in any engineering handbook, much figuring can be eliminated. With the circumscribed radius R known, we can substitute for the constants given. Thus:

The inscribed radius r is 0.9239 R = 0.9239 × 15.75 = 14.55 ft.

The side S is 0.7654 R = 0.7654 × 15.75 = 12.05 ft.

Area of the base is $2.8284\ R^2 = 2.8284 \times 15.75^2 = 700$ sq ft.

The average load is W_r area = 870.5 ÷ 700 = 1.25 tons per sq ft.

With e falling at the *kern* line, the toe pressure becomes 2.5 tons and the heel pressure zero tons per square foot.

The dotted line on the foundation, Fig. 1, represents the uniform loading of 1.25 tons per sq ft on the soil with no wind pressure. This clearly shows the importance of loading within the *kern*. When the resultant force cuts the base beyond the *kern*, the toe pressure increases rapidly, while at the heel an uplift or negative pressure appears. Whatever shape the base may be, the *kern* must be carefully determined, in order to have a well designed foundation.

It will be necessary to investigate the chimney shaft at the base for the maximum compression S_1 on the leeward side and for the maximum tension S_2 on the windward side. This should be calculated for an average wind pressure of 25 lb and 20 lb per sq ft respectively. The wall thickness at the base is 24 in. or 2 ft. See Fig. 4.

Let: W is weight of chimney and lining = 600 tons.

A is area of section = $0.7854(16.5^2 - 12.5^2) = 91.1$ sq ft.

M is moment at 25 lb per sq ft = 2,839.5 ft-tons.

M is moment at 20 lb per sq ft = 2,271.6 ft-tons.

S, the section modulus = $\dfrac{0.0982(16.5^4 - 12.5^4)}{16.5} = 296$

$\dfrac{\text{Weight}}{\text{Area}} \pm \dfrac{M}{SM} = \dfrac{600}{91.1} \pm \dfrac{2{,}839.5}{296} = 6.58 \pm 9.90$

$S_1 = +16.18$ tons per sq ft compression or 224 psi.

$S_2 = -3.02$ tons per sq ft tension or 42 psi.

$\dfrac{\text{Weight}}{\text{Area}} \pm \dfrac{M}{SM} = \dfrac{600}{91.1} \pm \dfrac{2{,}271.6}{296} = 6.58 \pm 7.67$

$S_1 = +14.25$ tons per sq ft compression or 198 psi

$S_2 = -1.09$ tons per sq ft tension or 15.1 psi.

Chimneys should be equipped with properly designed lightning rods connected to well grounded leads. Records of insurance companies show that good lightning rods are 99 per cent efficient.

Federal, state, and local codes and ordinances must be complied with in providing air-navigation markings and lighting for day and night flying. Refer to the Civil Aeronautics Authority for the regulations governing this.

Editor's Note: In a subsequent article, J. G. Mingle, one of the country's authorities on chimneys, will present a discussion of the relation of chimney size to control of smoke and will also discuss most economical chimney size.

Questions and Answers

Your fellow engineers will answer your power engineering questions.

You answer theirs, get paid well. Simple? Effective? Why don't you try it?

Answer No. 496

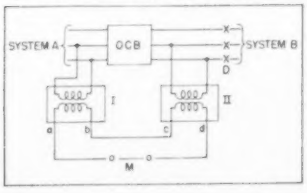
How Should He Hook Up Synchronizing Transformers?

Tests for Correct Polarity

A REPLY on page 88 of the September 1952 issue about "hooking up" a synchronizing transformer directs attention to closely observing polarity markings to assure correct indication. No details being given as to the tests needed to be certain about the correct connections it seems in order to offer comments about a simple test to give a positive result for polarity.

A generating station as indicated on attached diagram is to be synchronized with a supply line. Assuming the phase sequence (rotation) has been checked by means of lamps, sequence meter or motor there still remains the details of connecting the secondaries of the potential transformers I and II correctly.

Fig. 1. von Dannenberg connects it up like this



Potential transformers usually have their polarities indicated but when one considers the literally thousands of units produced it is not at all unusual to have one put out with incorrect marking. In addition the distance between I and II may be appreciable and even with code colored leads an interchange is possible.

With the station leads disconnected at 'D' to separate the station or machine from the line and the potential transformers connected as shown the OCB may be closed and the condition indicated by the lamps or other testing device at M will be the correct one at synchronism. If the lamps are bright it will indicate double voltage and if "dark" synchronizing is desired the potential transformer secondary connections can be reversed at either I or II so that 'a' will be to 'c' and 'b' to 'd'; a further test should then be made to be sure of the correctness. The OCB can then be opened and the station or generator leads reconnected at 'D'.

The advantage of the method described is its simplicity and certainty in result which is a positive one. In addition the tests can be made with all equipment in place and no dependence on an assumed polarity or one made at some point away from the installation. From a practical standpoint it is a most desirable method.

Brooklyn, N. Y. C. O. VON DANNENBERG

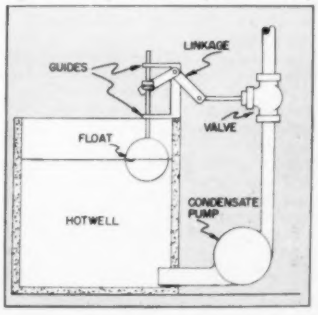
Answer No. 497

What Can He Do About This Hotwell Pump?

Keep Water Level Constant

I BELIEVE this problem can be solved by using a plan similar to the one shown in the sketch. A valve is installed in the discharge line of the

Fig. 2. Parks says to solve the problem this way



condensate pump which is connected by linkage to a float riding in guides. In operation, when water level falls in the hotwell the float lowers and partly closes the valve which throttles pump discharge. When level comes back up the float raises and opens the valve. This procedure tends to keep a fairly constant level in the hotwell and at the same time keeps the line filled with water. Float can be adjusted for any desired level. Limit switches can be installed to start and stop the pump at any extreme level (low) of water. This system works well on a great many jobs and should work here.

Overlea, Md. C. W. PARKS

Use Heat Exchanger

I WOULD suggest M.P. install a heat exchanger in his hotwell through which he could run his makeup to water softener or feedwater heater. In this way makeup water would absorb excess heat in the condensate and no heat would be lost in the process. He could size the heat exchanger so it would reduce temperature of his condensate to the point where the pump would handle it with the present available net positive suction head.

Clinton, Ia. C. J. WERDERITCH

Answer No. 498

Will His Pump Lose Suction After Shutdown?

von Dannenberg says—

THE REPLIES have been so varied the writer is reluctant to add to the voluminous offerings, however, sufficient accent does not seem to have been given to certain essential and basically fundamental features.

A fire pump must first of all be available for *immediate service* with the least possible delay since its effectiveness depends upon availability at the incipient stage of the fire. No pump the writer knows of even with the most careful installation can be depended upon to give immediate service with a 530 ft suction even when the lift is small and a foot or swing check valve is definitely in order and the added expense is insignificant as an element of cost in the total installation.

The writer's experience was based on taking water from a river where of necessity a long suction was required due to the flat terrain and rocky nature of the bottom and the wide seasonal variations in the river level. The insurance authorities insisted on priming facilities from an elevated tank and definite priming at least once on each eight-hour shift with records kept of each operation. The lift was about 10 feet but even with the suction filled at high river level, an appreciable time was required to obtain pump discharge before a swing check valve was placed at the end of the suction. With the suction full, immediate service was of course available with the system full. A foot valve particularly for fire pump service is positively in order.

Brooklyn, N. Y. C. O. VON DANNENBERG

Answer No. 500

How Can He Forestall Diesel Crankcase Explosions?

Alarms vs Direct Controls

CONSIDERABLE accidental damage has been prevented by automatic electric switches designed to signal diesel operators when improper conditions develop during normal operation. These are usually pressure and temperature controlled switches wired to visible and audible alarms. Most are usually installed to respond to low oil pressure and high oil temperature.

The advisability of having these units function as alarms or as direct-operating controls to automatically stop an engine requires considerable study. On a single engine in operation, stopping does not match the complications that would result stopping one of two paralleled units, where the entire load would shift to the remaining unit in operation and ultimately overheat it and drop it from service.

Methods of stopping diesel engines are numerous and some have serious disadvantages. Obviously, stopping fuel supply to injection pumps is easily accomplished through a solenoid valve in the fuel supply line. The engine, however, will continue to fire on the remaining fuel between the valve and injection pump valves. When the injection valves run low on fuel often air will be sucked into the line, preventing proper fuel-ignition in the cylinders when the engine is restarted.

Stopping injection pump action is most commonly used due to its quick action and elimination of air binding in the pumps. Electrical release of a spring overcomes engine governor springs and moves the fuel pump governor into shutoff position.

Holding an exhaust valve open will stop diesel operation because cylinders require compression for fuel ignition. This immediately stops compression and firing ceases. Additional advantage of this method is the ability to stop an engine if excessive fuel is being passed due to a defective fuel pump or governor. It is also valuable in the case of a two-cycle engine that is overspeeding due to lubricating oil drawn from the crankcase following through air inlet ports and being burned in the cylinders.

Comparing the performance of two identical units in different plants is much like comparing operation of one automobile model against another. Neither operate under identical maintenance conditions. The reason why one engine operates without trouble is apparently because it is regularly checked with a cylinder pressure indicator and pressures always kept within a few pounds of each other.

Regardless of engine condition it still must develop 1.34 hp to produce 1 kw. In pulling full-rated load, a 10 to 30 per cent fuel increase may be necessary because of lowered physical condition. Fuel injection timing is automatically advanced when the extra fuel is added.

Leaky piston rings with increased blowby require still more fuel, and with the rack-rotating fuel pump increasing fuel volume, fuel-injection timing is again advanced.

And, if water-jacket temperature is too low, combustion is delayed as fuel burns improperly and more fuel is again necessary, increasing injection timing.

With fuel nozzles and pumps in poor condition, poor atomization results in incomplete combustion. This means more fuel and finally fuel-injection timing is advanced beyond designed limit increasing the possibility of bearing troubles, crankshaft scoring, and cracked or deflected cylinder heads.

Modern diesel engines have an enviable safety record on a par with turbines, as any plant operator can attest. This safety record is possible only with constant maintenance and pressure checks as in any prime mover operation, steam or water.

L. W. FITZPATRICK

Jefferson City, Mo.

Combination of Causes

IT APPEARS to me that there is a combination of several possible causes for the 20 per cent difference in metered steam flows as reported by M. J. H.

If steam temperatures, pressures and quality differ from the meters' design conditions, applying a correction factor to each planimetered quantity to correct for variation of metered specific volume from design specific volume will eliminate some of the total meter error.

Since M.J.H. indicates that orifices are being used instead of flow nozzles, it is quite possible that scale has built up on the knife edges of the holes thus altering the discharge coefficient of the orifices. All orifice plates should be removed and cleaned, and the meters calibrated.

In some old meters it is also possible to blow part of the mercury out of the instrument when putting a boiler on the line, if other than an experienced instrument man cuts the meter in service. This should be checked as a possible trouble point.

Finally, there should be a minimum of 15 diameters of straight pipe run upstream from the orifice plate and 5 diameters downstream to assure a correct flow pattern through the orifice.

Lake Jackson, Tex. T. E. POUNDS

Eliminate Cause, Says Tatman

CRANKCASE explosion safeguard devices are good, but to eliminate the cause is better.

Any shutdown device is just as reliable as the company that manufactures it. There are at least a dozen reliable manufacturers of shutdown

or safety devices. The writer has had experience with most of them and finds them reliable, if kept in good condition.

Most any manufacturer of automatic or safety diesel engine or steam boiler controls, whose advertisement appears in the trade journals, can be relied upon.

There are several ways a diesel engine may be automatically shut down. (1) By shutting off the fuel supply to the injection pumps; (2) By cutting off the air supply to the engine; (2) By stopping the action of the fuel injection pumps. Any one of the three systems would be actuated by an electric switch that responds to a small change in pressure in the crankcase. These instruments are available in pressure ranges from 0 to 2 lb, or from 0 to 15 lb. This electric pressure switch will in turn energize a solenoid valve or a solenoid trip, depending on which device is used.

In order to be able to choose the system that would best fill your needs, one should know something about the different systems. No diesel engine can run very long without oxygen. By using a butterfly valve in the air intake line the air could be shut off to the engine. This valve could be closed automatically by a weighted lever after the holding latch has been released electrically, but this is slow for it will take a little while for the engine to use up all the air in the manifold and air line.

To close a valve in the fuel supply line to the injection pumps, there is a very simple system, using a solenoid valve in the fuel line. This valve is actuated by the pressure switch connected to the crankcase, but this system has its disadvantages. Even with the shutoff valve located as close to the injection pumps as possible, there will still be an appreciable time lag between the time the pressure switch operates and the engine actually stops firing, because of the fuel left in the fuel line and injection pumps. Also injection pumps will often suck in air when run without fuel for just a little while and will take some time to work all this air out before the engine can be started again.

Stopping the action of the fuel injection pumps is the best method and the method most used. The firing will cease almost instantly with the operating of the pressure switch. The stopping of the fuel injection pumps is usually accomplished by a spring arranged to overcome the engine governor spring and pull the regulating lever of the fuel injection pumps to the OFF position. This spring is held in the non-operating position while the engine is running by a latch that is released by an electric solenoid.

Power for these shutdown devices may be taken from the starting batteries or from any other source of power as long as the solenoid and switches are for the voltage that is going to be used.

Another good safeguard is to install a low-pressure high-capacity pressure relief plate in each crankcase inspection door, as shown in sketch. This would not take the place of a shutdown device, but rather in addition to it.

Any oil vapor present in a diesel crankcase after the engine has been run for a few hours can be explosive. If the crankcase is opened up immediately after the engine has been shut down, open lights and fire should be kept away until the hot vapor has had time to clear away. This is extremely important if the engine has been shut down due to a hot bearing or a piston blowby. In fact, it is a good policy to let the engine cool down a little before attempting to open it up at all.

Crankcases can be vented to the atmosphere outside the building to carry away these vapors or, better yet, operate with a slight vacuum in the crankcase created by pulling the vapors out with a connection to the suction side of the scavenger pump or to the air intake line. This way the oil vapors are pulled into the engine and burned, greatly reducing the possibility of an explosion and helping to keep down oil leaks around the inspection plates.

Safety devices only operate after some abnormal operating condition has been allowed to manifest itself, and they should not be considered as something that will take the place of a routine preventive maintenance schedule. The best assurance against crankcase explosions or other mechanical damage to any equipment is a well set-up preventive maintenance schedule, religiously adhered to.

Puerto Rico W. O. TATMAN

"If I had last night to live over, I think I would have paid more attention to the oil pressure!"

Answer No. 501

Why Do These Steam Flows Differ by 20%?

IN THE OCTOBER issue M. J. H. stated: Our problem is that we cannot get reasonable agreement between the total steam metered into the header and the total metered out to the departments. The total metered in runs from 15 to 20 per cent more than the total metered out. The percentage discrepancy varies only a little with variations in plant load.

M. J. H. thinks such a discrepancy should not run more than 5 per cent, but he is unable to account for his existing 20 per cent.

Evans Suggests These Checks

I WOULD CHECK the following:

(1) Location of orifice plate with respect to length of straight pipe up- and downstream from the orifice taps.

(2) Orifice plate wear on the plant lines and proper centering of the orifice in the flanges.

It is generally not reasonable to expect more than 5 per cent difference due to condensation; however, with a small flow in a line 1000-ft long the error could be greater. More details are needed.

Chicago, Ill. M. EVANS

Why Not Meter Condensate?

I WAS READING Question No. 501 and cannot answer it for M. J. H., but I would make this suggestion. Since he has steam in and out metered, why not meter the condensate and figure the steam loss from that? That would show him if he is right or wrong on his efficiency estimation of 5 per cent.

Miloca, Minn. DON COCHRANE

Pressure Calibrate Flowmeters

IT IS QUITE annoying when you are having car trouble to have someone helpfully ask, "Are you sure you're not out of gas?" The question regarding variation in flowmeter readings could easily lead to a number of answers comparable to the "out of gas" solution.

We, however, are going to assume that M. J. H. knows his business or he would not be in charge of five boilers, and that he has already investigated all logical solutions.

First and most natural reaction to this question is that some of the meters are out of order, but since M. J. H. says they have been checked let us assume they are correctly recording impulse received by them individually.

One-hundred thousand lb of steam per hr metered into the main header must be 100,000 lb of steam per hr going out, either by condensation to traps or leaks, or through other metered orifices. There is, however, a point which impresses us at once; namely, the fact that the outgoing orifice locations are at different distances, as much as 1000 ft, from the main header. If all outgoing flowmeters are calibrated for the same pressure, unless they are variable pressure recorders there will be a decided difference in the way each meter will record 100,000 lb of steam. They may all be correctly recording the impulses they receive, but unless each flowmeter is calibrated for the steam pressure at its own orifice, there will be considerable discrepancy between their recordings and the actual steam flow.

Suppose, for instance, the pressure at the orifice 1000-ft away is taken as the operating pressure. An orifice 250-ft from the header would be under considerably higher pressure and would record a lower rate of flow.

In our mill the steam pressure under full load drops from 430 lb drum pressure to 380 to 390 lb at the turbine throttle — about 150-ft of 8-in. pipe distant. The same flowmeter which records 50,000 lb per hr out of one of the boilers, if hooked up at the turbine throttle would show a substantial increase in steam flow.

If M. J. H. has not already acted on this theory, we would like to suggest that he do so and calibrate the individual distribution flowmeters according to the actual steam pressure at each meter.

If this is not the answer, we should like to see published more information such as pressure carried, steam flow per hr, pipe sizes, etc.

Au Sable Forks, N. Y.
GILBERT J. WELLS
DONALD RUSHMORE

Recheck Flowmeters, Says Fitzpatrick

WHILE FLOWMETERS are purchased to meter flow under a specified set of conditions, often after installation has been completed, it will be found that actual conditions differ materially from those for which the meter was originally specified.

These later conditions make necessary the use of entirely different multiplying factors in order to obtain correct flow measurement. It will also be found that since an orifice meter is designed for a definite fluid, meter readings obviously must be corrected for pressure changes, superheat or steam quality. All orifice meters are designed for steady flow and a pulsating flow may cause the meter to read high.

An electrically operated demand recording attachment would show in this case whether the flowmeter orifice plate is oversize. The plate size should be changed to measure actual line loss in the distribution system with all steam load shut off.

The recording attachment will definitely prove whether the meter is oversized. With a correctly sized orifice plate, any meter will correctly record a small steam flow. A restrictive plate on the downstream side will aid in recording low loads.

Flowmeters should always read as near full scale as possible since that is the range of greatest accuracy. Often this will require changing scales for spring and fall steam demands. In checking a flowmeter installation, boiler pressure must remain constant and distribution line steam pressures should be tested by gage at other meter orifices. If they vary appreciably or boiler pressure drops and swings under heavy loads, meter readings will be incorrect. A corrected multiplication factor must be used to get true steam output at lower pressure.

L. W. FITZPATRICK

Jefferson City, Mo.

Meter Correction Factor

A 20 PER CENT discrepancy between the measured flows into and out of the common header seems to be out of line, and M J.H. should check several points in his set-up.

If the calibration of the flowmeters is accurate and has been checked, there remains a common discrepancy which can be easily corrected. Steam flowmeters are calibrated at a given temperature and pressure, which means a specified specific volume of steam passing through the orifice. M.J.H. should determine the calibrating conditions of each of his meters and also the actual temperature and pressure of the steam in each line at the point where the orifice is installed. If the calibrating and actual conditions are different, and they usually are, a correction must be applied to the meter reading obtained.

The correction is made by dividing the specific volume of the steam at the calibrating conditions by the specific volume at the actual conditions at the orifice; taking the square root of this quotient and multiplying the square root by the steam flow which is read on the meter.

As an equation this appears:

$$W_1 = W_2 \sqrt{\frac{V_2}{V_1}}$$

Where: W_1 = Actual flow, lb per hr
W_2 = Flowmeter reading, lb per hr
V_2 = Specific volume at which meter was calibrated, cu ft per lb
V_1 = Specific volume actually present at the orifice, cu ft per lb

M.J.H. must make this correction for all the flowmeter readings, both those on the main steam lines and those on the distribution lines from the common header. This procedure should bring the flowmeter readings into line. Even 5 per cent of the total steam condensing in the line seems high, but this would be controlled by the pipe surface exposed to air.

F. M. BRUNN

West Englewood, N. J.

Check List From DeLong

WHEN DIFFERENCES in readings of steam generated and steam used are found, the following points can be checked:

(1) Meter orifices worn.

(2) Burrs in inlet tubes at meter orifices.

(3) Pressure drop in long lines will cause an error if not corrected for. However, this pressure would normally be positive.

(4) Condensation loss should be calculated instead of estimated.

(5) Leaky traps and drips in pipe lines between boiler meter orifices and distribution meter orifices can result in considerable differences in readings.

(6) Jumpy flows in the distribution lines may at times result in low or high integrator readings.

Inasmuch as the percentage change is fairly constant, the losses right at the orifices may be the most pertinent. However, other causes which should be checked are: meter pots out of level; calibration weights left on meters after checking; air in meters.

Philadelphia, Pa. A. F. DELONG

Slip Ring Controller Problem Remedied

By JOHN FOSTER

RECENTLY a 25-hp, three-phase, slip ring a-c motor was installed to drive an ammonia compressor. A hand speed regulating controller and a push button operated magnetic line switch were also part of the installation.

After the equipment had been operating a few months, sticking of the sliding brushes of the controller was observed, and, at times, the brushes became partially welded to the stationary contact segments.

The controller was opened and the more badly burned segment contacts were replaced with new ones. The brushes, too, were removed and resurfaced with a file; even the brush sides were filed because the brushes appeared to have expanded in their holders, since they were found to be jammed tightly. The work finished, the controller was reassembled and the machine returned to service. Instructions were issued to the operating personnel not to accelerate the motor too rapidly, as it was believed this had been the cause of arcing which resulted in burned contacts.

The machine operated satisfactorily for a couple of weeks, until sticking of the controller contacts again occurred and the controller overhauling had to be repeated. After subsequent renewals of burned brushes and contact segments had further depleted the stock of replacement parts, and remedies based on changes in the material of which the brushes were made had been considered, the manufacturer's district office was consulted and a service engineer investigated the trouble.

The investigation revealed that, for some unknown reason, the workmen who had connected the controller had shunted out the pilot contacts in the controller that were intended to permit the magnetic line switch to close only when the controller was in lowest speed position. The result, of course, was that the line switch could be closed at any time by merely pressing the push button, regardless of whether the controller was in low or high speed position. This could permit a heavy rush of current through the brushes and contact segments, resulting in arcing and burning of the metal. The controller was therefore reconnected, additional contact segments replaced, brushes filed, and it was assumed no difficulties would be encountered.

Within a few more weeks, however, contact burning and brush jamming again occurred, and the service engineer was again summoned. Considerable dissatisfaction with the apparatus was felt and this was not kept secret from the engineer, who happened not to be the one sent previously.

This man made a number of instrument tests to determine the current flowing in the various parts of the several circuits in the motor, controller and line switch, under various motor speed conditions, and found all readings to be normal. He then examined the controller contacts and recommended that all brushes and contact segments be renewed, regardless of condition. This recommendation, of course, did not meet with enthusiastic approval, since it meant a considerable amount of additional labor similar to that performed, with so little favorable results, on a number of previous occasions. However, the work was done and the machine again put service.

That occurred a number of months ago and, to date, the machine has operated daily without once giving any indication of controller difficulty.

What Causes Pulsation in Centrifugal Blowers—

and How to Stop It

WHEN A CENTRIFUGAL BLOWER is used in the capacity range for which it was designed, pulsation is seldom a problem. There are, however, certain applications of blowers — where it is necessary to keep the blower running during periods of very small demand. In the case of certain heating processes these "turn-down" or "week-end holding" periods may call for as little as 10 or 20 per cent of rated volume output of the blower. In such cases, surging can set up a pulsation which may disturb the process and cause overheating and consequent damage.

Such pulsation can be prevented — and corrected — if one understands the mechanics of pulsation and the characteristics of a centrifugal blower, as here interpreted by O. W. Acheson, of the Billmyre Blower Division, Lamson Corp.

The pressure-vs-delivery curves shown in the accompanying sketch are typical of all centrifugal blowers, the upper curve being of a well-designed blower, and the lower curve of a "not-so-well" designed blower. Note that in both cases the pressure attains a maximum high point at some relatively low rate of air output, the curve rising at air delivery rates below this critical value and descending at rates above this critical value.

If the demand on a blower is decreased in volume from a normal operating point, A, to another normal operating point, B, above the maximum-pressure point, the pressure at the blower merely rises correspondingly, and pulsation does not occur. If, however, the load or volume requirement is decreased beyond the maximum-pressure point, E, to a very low point, such as C, the following sequence of circumstances may set up surging.

The blower delivery pressure first decreases from E to C *at the blower itself*. Thus for a moment, the pressure in the piping system connected to the blower is greater than the pressure at the blower itself. Thus the air in the line tends to reverse its direction and flow back into the blower (this can be extremely dangerous in handling gas to a burner or combustion chamber) until both pressures become equalized. When this is achieved the blower again resumes its normal function of pumping air into the system — until the restriction at the line outlet again reduces throughput and causes the sequence to repeat.

It is this repetition which constitutes surging.

The frequency and intensity of surging depends upon: (1) the slope of the pressure-vs-volume curve, (2) the rate at which air is being removed from the system, and (3) the volume of the pipe system to which the blower is delivering air. The same principles apply whether the centrifugal unit is operating as a blower or an exhauster.

The wisest action to take in the prevention of pulsation is the anticipation of circumstances which might cause it. The phenomenon will not occur in volumes above the point E. If the application is such that low turn-downs are expected, it is prudent to so indicate when the blower is being ordered. The blower manufacturer, can in most cases, select and specify to prevent pulsation.

If, however, pulsation or surging is noticed in a finished installation, any of the following four steps can be taken:

(1) Consider the economics of replacing the blower with a smaller capacity unit having a consequently lower surge point

(2) Consider purchasing a small capacity unit for turn-down periods

(3) Make sure that the amount of air delivered by the blower is always above the surge point by bleeding enough air out of the system beyond the blower. If you are handling gas rather than air it will be necessary to recirculate this bleed flow back into

the blower inlet. If you recirculate the bleed, however, remember that you are compressing and re-compressing that portion of the gas and building up the blower temperature to a point which may be detrimental.

(4) If the surging is infrequent and of short duration, it may not be harmful to the blower at all. Surging at the point of air or gas use may be eliminated by adding a surge tank or increasing the cubical content of the piping in front of the nozzle.

(5) Ask the manufacturer to make minor changes in the blower design to permit by-passing the air, or take other steps which will eliminate the troublesome pulsation at the sacrifice of a little blower efficiency or tightness of the installation.

Actually, the more efficient a blower operates and the tighter the air system is beyond the blower, the more likely it is to surge at very low operating points. Fortunately, the uses for compressed air or gas, which demand blower operation at critically low output, are infrequent so that the use of high-efficiency equipment can be used in all but rarest cases.

Thread Cutting in Power Plant Maintenance Work

By CHESMAN A. LEE

IN MAINTAINING power equipment, the engineer often needs to make or repair components having internal or external threads that must be cut in the lathe.

This article is intended primarily to show him an improved way of cutting internal threads. However, some comments on external threads may serve to introduce the subject.

Work may be on a "job-lot" basis, or only one piece may be required. It is assumed that work is not really on a "production basis" but that the engineer wants a reasonable combination of accuracy, appearance and speed. The remarks apply especially to the coarser pitches (e.g., $\frac{1}{4}$-in. pitch).

What Is Best Feed Angle?

It is assumed that the lathe has a compound rest. Then the threading tool can be fed in at an angle and a heavier cut may be taken. There are two choices: — Tool can be ground flat on top and fed in at 29 deg. See Fig. 1. It should have exactly 60-deg included angle. A moderate cut can be taken on leading edge and a scraping cut on trailing edge. This method is given in that perennial classic "How to Run a Lathe" (South Bend Lathe Works, 42nd Ed., 1942) and also in Shuman & Bardo's book "How to Operate a Lathe" (John Wiley & Sons, 1944). Calvin & Stanley's book "Turning and Boring Practice" (McGraw-Hill Book Co., 3rd Ed., 1948) recommend feeding in at 30 deg and that is the way I learned.

It is my practice to grind tool with top-rake and with less than 60 deg included angle for extra clearance. I set cutting angle exactly at 60 deg and get correct angle on other face by feeding in at exactly 30 deg (60 deg from the work). Such a tool, shown in Fig. 3, will remove chips rather than shavings, and will cut a good thread in little time.

Internal Threads

Internal threads are cut in much the same way. However, a boring bar does not offer as rigid a support as a regular tool holder and chattering can become a problem. A boring tool cuts on leading edge and naturally enough, good mechanics grind threading tool to cut on leading edge. Compound-rest is set 30 deg forward (reversed from position for male threading). This is as pictured in Shuman & Bardo's book. With tool cutting on leading edge, deflection will cause tool to cut deeper and may cause chatter. This is made clear by reference to Fig. 4.

My preference is to cut on trailing edge. I grind tool "backwards" as in Fig. 5, with top rake, and with less than 60 deg included angle. I leave compound-rest in natural position, 30 deg trailing, and don't "baby" the threading. Such a tool will speed up the work and can be used without keeping in practice. The finished thread is accurate.

As noted previously, the above ideas should be of most value for the coarser pitches. They work OK for the finer pitches but a comment is in order. It helps to have a small radius on point of tool. Radius would be quite small for the finer pitches.

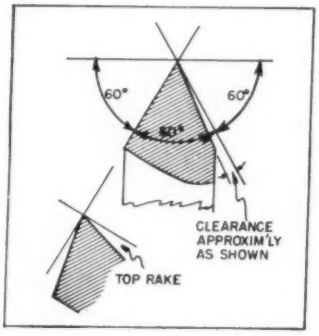


Fig. 3. Tool ground with top rake and clearance

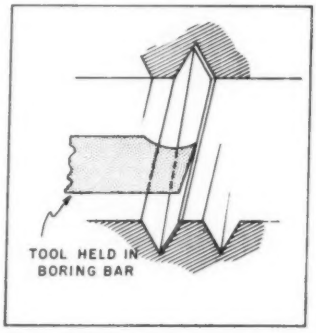


Fig. 4. Tool cutting on leading edge may chatter

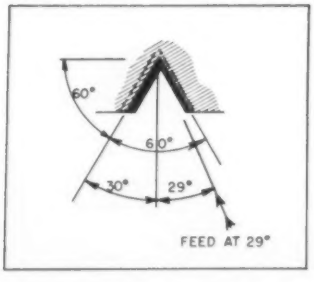


Fig. 1. Threading tool set for feed in at 29 deg

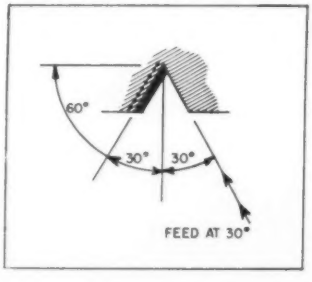


Fig. 2. Threading tool set for feed in at 30 deg

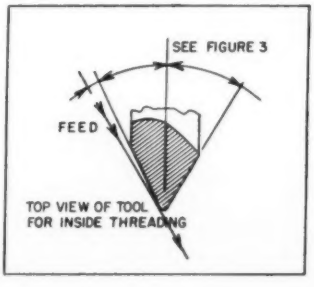


Fig. 5. Ground "backwards," cut on trailing edge

Can Fuel Oil Additives Diminish Boiler Slagging?

Field tests and extensive research have indicated the practical and economic feasibility of using oil additives to reduce boiler slagging. Here is a full report of the tests

SIGNIFICANT results in relieving troublesome deposits on boiler tubes from firing residual fuel oil have been achieved by The Babcock & Wilcox Company. Certain grades of oil such as Bunker C contain ash contents, which, upon combustion, result in depositing of a hard, tenacious residue on boiler heat transfer surfaces, particularly superheater tubes.

This situation has been aggravated by the trend toward larger boilers with higher temperatures. Since ash-free oil of this grade is not economically feasible, the problem was attacked by controlling ash deposit characteristics.

Troublesome superheater deposits were characterized by low-melting constituents. Laboratory work was done on selected materials which, when mixed with oil ash, would raise melting points so that deposits would be dry and more readily removable by customary means. Effect on fusing temperatures by intimately mixing synthetic oil ash with various additives was studied using ASTM coal ash fusibility determinations.

First fusion cones were made from actual ash by burning a typical troublesome oil. This was tedious and expensive. All subsequent samples were compounded by mixing individual ingredients to obtain the same chemical composition as in oil ash. Comparable fusing temperatures were obtained with this synthetic ash. A number of materials were added individually to synthetic ash, and it was found that some mixtures had higher fusing temperatures than oil ash alone.

A pilot furnace was set up for testing promising additives under simulated operating conditions. Equipment consisted of a small furnace in which fuel-additive mixtures were burned and three air-cooled coils upon which deposits were collected. Coils were placed at different levels in the stack to study effect of various temperature zones on deposit formation.

Additive was mixed with fuel prior to combustion. It was believed effectiveness would thereby be increased because of more even dispersion through oil and more intimate contact with oil ash throughout combustion. For this, a mixing device was used, as shown in Fig. 1, with test equipment.

To accelerate tests and increase deposit formation, diesel oil with synthetic ash added was used to produce deposits similar to those obtained on commercial units.

Additives of finely divided materials suspended in fuel and metallic organic compounds of the soap type (soluble or miscible with oil) were tried in various weight ratios to ash in the oil. Alumina, magnesium oxide and calcium oxide were most promising, producing a powdery deposit easily removable from the coils. This contrasted with the hard, glassy, fused material formed when these additives were not used.

Aluminum stearate proved effective, but economic factors make its practical use doubtful. Finely divided alumina is commercially available at about 3.25 cents per lb in bulk and, when suspended in fuel in a ratio of 1 lb to 1 lb of ash solids, it appeared sufficiently practical and economically feasible to justify large scale trial.

Field Test Program

Arrangements were made for a test program on a commercial-size unit under actual operating conditions at the Florida Power Corporation's Inglis station. The unit is an FH boiler with a capacity of 300,000 lb of steam per hr at 900 psi and 910 F, and has an inverted-loop superheater. It carries a nearly constant 24-hr load of 275,000 lb per hr. It has a tube-to-tube furnace, fired with 6 Y-jet burners. No. 6 fuel oil is burned. Analysis of this oil showed 3.0 per cent sulfur and an average ash content of approximately 0.15 per cent. Noticeable quantities of water were common.

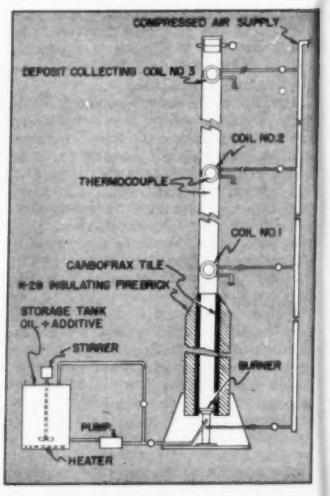


Fig. 1. Set-up used to pre-test various additives

In operation since 1947, the boiler was normally removed from service twice a year for cleaning. While operating, soot blowers, including three retractable units in the superheater cavity, were used every 8 hr. It has also been necessary to water-lance the superheater and air- and water-lance the airheater. To do this, a cleaning gang was employed 3 or 4 nights a week. During shutdown, cleaning process involved soaking boiler tubes with water 2 or 3 days to loosen deposits, and considerable hand work was required to remove hard-clinging portions.

Results of alumina tests confirmed that deposits in the superheater region were changed from a dense, hard slag to a relatively soft ash, and indicated it should be possible to keep the unit on the line indefinitely if furnace walls, screen tubes and superheater tubes were lanced with air at

225 psi once a week. It was found advisable to clean the airheater after lancing to remove material blown there from superheater and economizer tubes. Use of soot blowers has not been necessary; however, boiler water has been used on retractable soot blowers about once every 3 weeks to supplement air-lancing. The Inglis installation normally burns less than 20,000 lb of oil per hr. Using alumina in an amount equal to ash in the oil, the cost has been about $1 per hr or $750 per month.

Addition of alumina has increased atomizer wear so it is necessary to renew standard sprayer plates every 30 days. Special hardened-steel plates have been developed to alleviate this problem somewhat.

Dolomite was tried as the additive next. This material is available locally at Inglis for $12 or less a ton, equivalent to 18 cents per hr or $130 per month. It is a calcium-magnesium carbonate and as used is obtained from calcining kiln stack gases. Its fineness is 100 per cent through 325 mesh screen. Preliminary research indicated results comparable to those obtained with alumina.

Results confirmed laboratory findings. With dolomite, however, more fine powdery material was deposited in the first pass of the superheater. That section of the superheater in the second gas pass was clean after two months, and the third gas pass, consisting only of saturated surface, was also clean. Wear rate of sprayer plates continued strong. However, at another plant wear rate with dolomite has been slight.

There is every indication the unit can be kept clean of ash for an indefinite period with use of a 200-psi air lance every 5 to 7 days. However, lance doors must be provided to give access to all tube rows; and, air-jet discharge must be close to ash being removed.

There are indications additives have another advantage in lowering dew point of flue gases. Effect of dolomite on airheater corrosion is not yet fully known; but, a major part of the additive is $CaSO_4$, so probably a much smaller amount of free SO_3 is present in gases passing through the airheater. An apparatus for checking gas dew points was developed (Fig. 2) and has been used at Inglis and Higgins station of the Florida Power Corp., and at a Tampa Electric Co. station. It showed there may be a difference between dew point temperatures when firing the same oil with and without additives. With a 2.75 per cent sulfur fuel, a dew point temperature of 150 F was recorded with additives. Without additives, temperatures from 250 to 275 F were recorded.

Difference was also noted in deposits collected on the apparatus probe. Without additives, the deposit was dark brown, clinging, greasy-feeling, and did not crumble. With additives, it was dirty-grey, dry to the touch, and crumbling.

In general, field tests indicated it is commercially feasible to effect a real saving in labor required to keep a unit clean and operating efficiently with present day fuel oil. In addition, corrosiveness of gases from the stack is greatly reduced and flyash nuisance is not so great.

Recently another additive system has been installed on an FH boiler at Turner station of the Florida Power Corp. Its operation history has been similar to Inglis.

Procedure and equipment worked out with the Florida Power Corp. and The Babcock & Wilcox Co. proves a good example of a typical installation. Additive is mixed, batch-wise, in heated fuel oil which is kept agitated. This is fed in measured amounts to fuel oil ahead of the burner. At Inglis, where the firing rate is 2300 gal per hr, 200 gal at 200 F is withdrawn to a mixing tank every 4 hr, and 92 lb of additive added. A motor-driven stirrer maintains constant agitation and a reciprocating pump, adjusted to a 50-gal per hr feed rate, pumps the slurry into the line on the downstream side of burner control and regulating valves. This proportion works out to approximately 0.1 per cent dolomite.

A mixing tee in the additive loop of the main oil stream intensifies mixing action. In the piping arrangement fresh oil meets the slurry head-on and both streams make several right-angle turns before reaching oil burners, providing more turbulence and mixing.

Distribution of additive to each burner serves as a check on quality of mixing. Individual samples of treated oil are taken from each burner line to be analyzed for additive content.

Fig. 2. Equipment used to find flue gas dew points which was developed by the B & W Research Center

Plan Your Power Plant Lubrication

With a Practical Approach

By C. W. BELL, Sr.
Engineering Consultant

YOUR LUBRICATION PLAN SHOULD:

1—Look ahead to lubrication practices when specifying and purchasing equipment
2—Purchase lubricants from recognized reliable sources only
3—Make use of the best advice of both the equipment and the lubricant manufacturers
4—Set up complete detailed lubrication charts to control everyday practices
5—Provide clean, effective storage and dispensing facilities
6—Keep adequate, accurate records
7—Follow up every indication of irregularity particularly as a clue to threatening equipment failure, to get the best out of your lubricants

LUBRICATION, in common with many other processes, is measured largely by relative comparisons. In a figurative way, "The proof of the pudding is in the eating."

The Over-all Program

Earliest possible step in establishing well co-ordinated lubrication practices within any power plant, mill or factory is to include lubrication details in the original specifications.

Whether or not this is done, equipment descriptions such as instruction book cuts and drawings along with data on speeds and specific loading of lubricated parts should be obtained very early.

Equipment manufacturers recommendations on lubricants should be obtained. This frequently calls for more detailed advice than given in the printed instructions; but, with these data at hand, rough estimates of types and quantities of oil can be made.

Contract may then be made with an oil supplier and his service engineer should go over the whole layout to check the fitness of their various types and grades of lubricant against the various requirements.

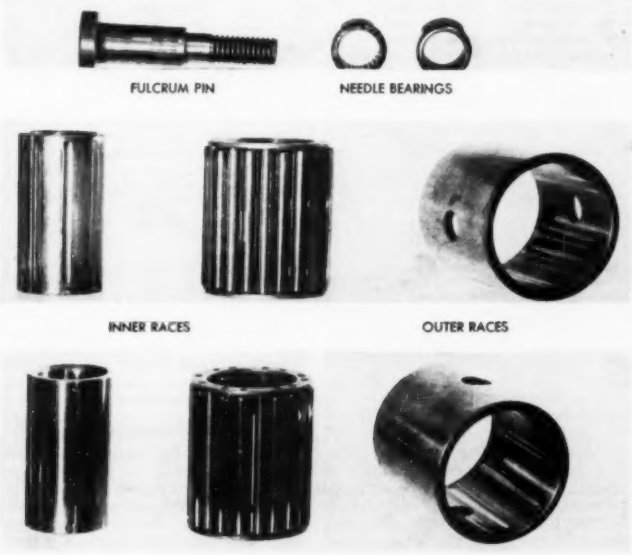
At this point, a good lubrication engineer (independent) can often do much good by serving as co-ordinator (sometimes referee).

Tentative Lubrication Charts should be set up and permanent consumption records established.

While the above applies to whole new layouts it should be applied in principle to extensions as well.

Inter-relations between condition of equipment and consumption of lubricants is also discussed here.

Fig. 1. Ball bearings or roller type bearings on mechanisms having little or no movement may cause this



A very good place to start on a lubrication program is in the selection of equipment where choices on type of bearings may sometimes be made thereby avoiding some lubrication problems.

Design of Equipment

On ball or roller bearings applied to shafts that move very little, such dampers or oscillating actions of say 10 deg or less, lubricants are very ineffective and should not be blamed for mal-functioning of the equipment as the balls or rollers will become "Brinnelled" into the races. (See Fig. 1.) It is sometimes possible to have bushed bearings substituted.

There are possibilities of choice of types of lubricating devices. For instance where bearings of numerous pieces of equipment require similar lubricant it is much better if they are equipped uniformly.

This is particularly true where pressure guns are called for. Unless distinctive non-interchangeable equipment is used for each type lubricant it is too easy for operators to make mistakes. (Code marking is sometimes used but is less effective.)

Fans, pumps, motors, and so on can often be equipped with either anti-friction or babbitted bearings. The controlling reason for choice here is not usually lubrication as such, but it should be considered.

Equipment Recommendations

In recent years much new equipment arrives with an instruction sheet that includes a brief recommendation or instruction to the installers to "buy XX gallon cans of Auto Engine oil #10–20 or 30 etc." This is the expedient thing to do. The oil is usually as good a grade as the case requires but it is not always the most appropriate for continuous application. It is likely to be more expensive than equally satisfactory industrial lubricants.

The same general practice is sometimes followed where greases are called for; but often with even poorer results, since not enough information is available to the equipment manufacturer as to expected ambient

Table I. Here is a typical lubrication chart form. Make one like it to fit your equipment and conditions and get all lubrication instructions on it for operators

LUBRICATION CHART

PLANT.....DEPT. (or Section).....

Equipment Unit	Bearings or Detail Lubricated	Lubricant Designation	Application		Check Freq.	Drain or Clean and Refill	Disposal
			How Applied	Frequency			
Pulverizer Mills #1 & 2	Motor	Turbine A	Ring oiled		1 hr.	3 mo.	Reclaim
	Back Mill Brg.	Spec HFS 3	" "		1 hr.	On Lab Test	Coal pile
	Drive Gears & Front Brg.	Spec HFS 3	Gear dip circulation		1 hr.	" " "	" "
	Flex. Coupling	Grease #5	Press Gun A		wkly.	Annual	Coal pile
	Mill Air Seals	Grease #6	Press Gun B	Daily	1 hr.	—	
Stokers 1 & 2 (Traveling Grate)	Motor	Turbine A	Ring Oiled		1 hr.	3 mo.	Reclaim
	Drive chain	Turbine D	Chain Dip		Daily	3 mo.	"
	Speed Changer	Turbine D	Immersion		Daily	6 mo.	"
	Output Chain	Turbine D	Chain Dip		Daily	3 mo.	"
	Worm & Gear	Gear Grease 30	Immersion		Daily	Annual	Coal pile
	" " " Brgs.	Grease #3	Press Gun C	Daily		Annual*	—
	Rear Stoker Shaft	Grease #6	Press Gun B	8 hr.		Annual*	—
	Front " "	Recl'd Turb C&D	Wick Feed Cups	As Req'd	1 hr.	Annual*	—
Air Compressors #3 & 4	Motor Brgs.	Grease #3	Grease Pack	Monthly	1 hr.	Annual	
	Air Cylinder	Air Comp Oil 300	Mech Lubtr.	2 Drp/min	8 hr.	Lub-Annual	—
	Crank Case, Ecc. & Main Brgs.	Engine Oil B	Splash	As Req'd	Daily	Annual	Reclaim
	External Mechanism	Grease #3 / Recl'd Turb A&B	Compress Cps / Squirt Can	As Req'd / 1 hour	1 hr.		—
Locomotive 10 (partial list)	Journal	HFS Journal oil	Wick Feed Cups	As Req'd	1 hr. max	Annual*	
	Steam Cyls	Cyl. Oil #6	Mech. Lubtr.	" "	1 hr.		
	Guides & Links	HFS Journal Oil	Oil Cups	" "	1 hr. max		
	Air Comp–Air Cylinder	Air Comp. Oil 400	Drip Type Cups	" "	1 hr. max		

* Inspection.
Note A:—An extension of this sheet to the right will be found convenient for special notes—See text.
Note B:—All Lubricant designations are arbitrary and do not represent specific designations of any one manufacturer; also the frequencies written into this form may or may not be applicable though they represent what is considered good practice under certain operating conditions.
Note C:—If the combination of equipment listed here were actually to appear in one plant simplifications would probably be made to reduce the number of stock items.

temperatures, moisture, and the like.

Even with instruction sheets expressed in terms of well-known grades of industrial lubricants, there is considerable variation in opinions.

With such handicaps as a starter and the usual rush to get equipment into service, the operators of new installations frequently find themselves facing an extremely confusing combination of instructions. They may have similar pieces of equipment being lubricated with different grades of lubricant; and even radically different service conditions being started off with some common grade of lubricant.

Refiners' Recommendations

As soon as the source of lubricants has been settled, the Lubrication Service Engineer of the refiner or supplier should be called in to make his recommendations. A great deal of weight should be given to their conclusions but in case of serious differences between the equipment manufacturers' specified lubricant and those recommended by the refiner, the two parties should get together with the operators or a specified representative.

The refiner's representative is assumed here to be an experienced, well qualified lubrication engineer, thoroughly familiar with the characteristics and probable behavior of every lubricant offered even under abnormal conditions.

The refiner should, at this point, furnish ample-sized control samples of each lubricant recommended.

Table II. In addition to normal lubrication chart of Table I, you need a schedule for cleaning and draining

PLANT.....DEPT. (Or Section).....Year....

LUBRICATION SCHEDULE—DRAINING AND CLEANING BEARINGS, LUBRICATORS, ETC.

Mo.	1st Week	2nd Week	3rd Week	4th Week	5th Week (or remarks)
January	#1 Mill*	#3 FD Fan	#2 Heater Pump	#1 Service Pump	
	#1 Exhauster*	#3A ID Fan	#1 Boiler Fd Pump	#1 Dryer Stoker,*	
	#1 Mill Feeder*	#3B ID Fan	#2 Booster Pump	Speed Changer,	
	#4 Air Comp'r. C Case	#2 Dryer Stoker Drive Chains only	#1 Fuel Oil Pump	Worm Gears, Drive Chains, etc.	
	#4 Booster Pump			#1 Dryer*	
February	#1 FD Fan	#2 Mill*	#2 Service Pump	#3 Booster Pump	
	#1A ID Fan	#2 Exhauster*	#2 Boiler Fd Pump	#2 Fuel Oil Pump	
	#1B ID Fan	#2 Mill Feeder*	#3 Air Comp.*		

* Co-incident with general inspection and overhaul.
Notes:—Unless otherwise specified all items include bearings of drive motor or turbine. Where this draining and cleaning schedule is handled by shift men the responsibility may be designated by "A"—"B" or "C" and the maintenance crew by "M," each item to be appropriately marked.
If there are a hundred items per year to handle obviously there will be roughly two per week to schedule. The whole list of plant equipment must be reviewed for this. Allowance must be made for extended maintenance jobs conflicting with the normal Lubrication schedule.
This schedule can best be set up a full 30 days ahead, i.e., the January schedule should be ready Dec. 1. (Along with January revised Maintenance program.) This gives time for any special preparations and usually avoids major revisions due to variations in service requirements and hours.

If customer-owned laboratory facilities are available, each sample should be tested and the results compared with stated characteristics. Where commercial laboratories are resorted to, some of the less important samples may be deferred until specific questions arise. In all cases, 8-oz. portions of each sample of liquid lubricant should be transferred to standard cylindrical sample bottles for visual comparison with similar samples from new shipments.

All new shipments received should be sampled and appropriated comparisons made before using any lubricant — which means before removal from original container.

Lubrication Survey

This survey will cover a number of important points.

(a) Lubricants will be chosen to suit not only the particular unit and bearing types but suitable weight will be given to conditions of service

such as temperature and moisture.

(b) For similar service a single stock lubricant will be used — reducing the stores items.

(c) A further reduction of stock items can often be made by lubricating isolated special cases with the next better grade lubricant.

(d) Where any large circulating oil system is used, the same grade of oil may be applicable to many independent items and make it practicable to draw used oil from the main system so as to keep the oil there sweetened with new make up.

An example is a turbine oil system and many sleeve bearing motors in a power plant.

This general policy is sometimes capable of extension to the hand oiled items. Any such plan requires detailed study, because an excessive withdrawal from a circulating system may result in increased over-all cost, while inadequate sweetening of circulating oil tends toward earlier breakdown and too frequent discarding of large batches.

Qualities—Types—Grades

Two general concepts often appear to be in opposition, in making decisions on the quality of lubricants to use.

One is that of price per gallon or pound. To adopt this approach, the basic start would be with a low-grade oil. For rough gears, consideration would be given to ordinary black car oil or to so called residium. This would be used for all applications up to duty where it proved unsuited. The same approach would be used for liquid lubricants where a very ordinary red engine oil would be the bulk basic item for use up the scale of service and responsibility to where persistant trouble developed. Ordinary yellow cup grease would be used for all grease application until it proved by costly experience that something different must be used in certain places.

The above method will obviously reduce stock inventory investment, but in the end is certain to be costly, because of equipment failures due to lubrication deficiency.

Price per unit of purchased lubricant is not a satisfactory approach.

The other approach is to work, in general, from the top down. This plan gives consideration to the best material offered by any reliable oil company for each of the conditions involved, as well as to the equipment manufacturers specifications. An engineer experienced in lubrication problems, along with the best talent available from the oil manufacturers, can set up a complete lubrication plan that will require very few modifications per hundred situations.

For instance, a given gear set must be analyzed as to fluidity of lubricant required under its full range of temperatures so that the material used will circulate or splash enough to give immediate effective lubrication as soon as the set starts. It must have film strength to fully maintain separation of surfaces at full operating temperature; and, as far as possible, it should not be necessary to make seasonal changes.

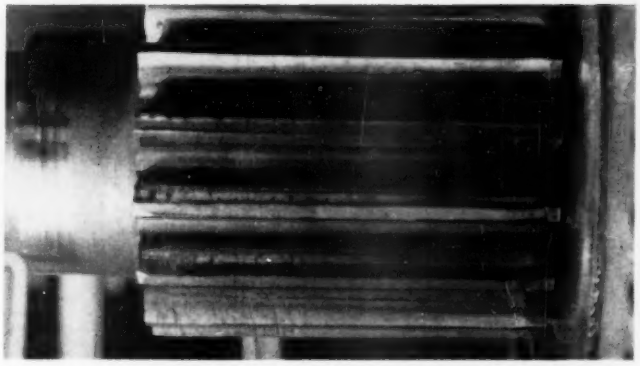


Fig. 2. Effect of incorrect lubrication on intermediate pinion in gear box for skip hoist. Working load in both directions. Splash lubrication did not apply lubricant to loaded side of gear teeth. Starting loads too heavy for indefinite application of lubricant. Some more effective lubrication method is required

Where moisture may be a factor, as it is with high speed reduction gears driven by close-coupled steam turbines, the lubricant must be capable of performing its functions for long periods without serious deterioration — washing out of inhibitors, emulsification, and the like.

Starting Torque Important

Among the important items to consider is that of starting torques. This is the highest load impressed at any time on gears carrying dead load. This applies to conveyors, hoists, some grinding or crushing operations. Where special forced lubrication is not applied at starting, there must be a sufficient coating retained after indefinite idle periods. Figure 2 illustrates this.

Fig. 3. This stoker drive and worm gear operated satisfactorily when worm was partly submerged. But slightly lower oil level caused trouble shown

Gears are discussed above partly because they are more critical and partly because they represent a greater variety of similar conditions met at various spots in other equipment where, in general, the same principle applies.

Give consideration to all conditions and select the lubricant that appears to have the best characteristics even if the cost per gallon is some multiple of the cheapest one considered.

One common misconception in bearing behavior is that a relatively warm bearing needs a heavier bodied oil. In rare cases this is true but more often lighter body oil will improve lubrication.

Another example is heavily loaded worm gears, where an oil of medium or low viscosity — 300 to 600 at 200 F — with suitable extreme pressure additive, may do an outstandingly better job when flowed on than a very viscous oil (or so called gear grease) which has to be warmed up before it can function in a natural manner. The warming up process is almost always co-incident with scoring of the gears and worm, as shown in Fig. 3.

General rules are a bit risky but one reasonable principle to apply is to use the lowest viscosity lubricant that will carry the load. In all cases it must be sufficiently fluid to be fully effective at its lowest operating temperature and meet every other requirement.

Adding Lubricant

The above applies largely to starting off new installations. Where new equipment is added to an established plant it is quite likely that most of the new can be lubricated the same as existing units or at the most only a few added items will be necessary.

On the other hand, added new equipment must be studied as crit-

(*Continued on page 111*)

Voltage Regulators

Fig. 1. A direct-acting electro-mechanical type voltage regulator

Fig. 2. Control unit—indirect-acting electro-mechanical regulator

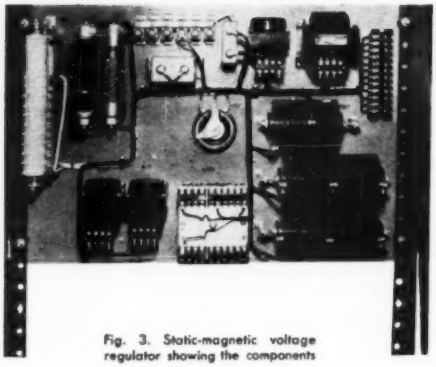


Fig. 3. Static-magnetic voltage regulator showing the components

Excitation Systems—1952 Style

By
W. A. HUNTER and **S. R. FOLGER**
General Electric Company

Various types of excitation systems were covered in a previous article. Now the authors show how voltage regulators work and what they do in these systems to help machines meet changing loads

THE USE OF VOLTAGE REGULATORS to automatically control the excitation systems of large a-c generators and synchronous condensers has steadily increased during recent years. Today, nearly all new synchronous machines are equipped with voltage regulators, and in many cases they are being added to units which have been in operation for some time without them. The increased use of regulators is a result of several factors. Voltage regulators can maintain the terminal voltage of all sizes of synchronous machines within very narrow limits (one per cent of normal or better) under ordinary operating conditions with widely varying loads and without the attention of operating personnel. They may be used in unattended stations to control the excitation of large machines through the complete operating cycle from start-up to shutdown. As a result, regulators have greatly simplified operating problems connected with the close regulation of machine and system voltages, and in many cases provide the only means by which satisfactory steady state voltage regulation can be achieved.

Automatic voltage regulators must be applied where extremely rapid changes in synchronous machine excitation are required at the time of system disturbances. Modern regulators will start corrective action in a small fraction of a second following a change in machine voltage. This action, which is much more rapid than could be obtained with manual control, permits maintaining machine and system voltages within much closer limits. The rapidity with which regulators act makes it possible to operate automatically regulated machines closer to their stability limits without loss of synchronism.

Voltage regulators used in today's excitation systems may be classified in several ways, i.e. by function, method of operation, and design. With respect to function, the two basic types are; proportional and non-proportional regulators.

Proportional regulators operate to provide a corrective action which is proportional to, but not necessarily a linear function of, the deviation of machine terminal voltage from that value which the regulator is adjusted to maintain. In general terms this means that the further the machine terminal voltage deviates from the desired value, the greater will be the effort made by the regulator to return the voltage to the desired value.

Non-proportional regulators operate to provide corrective action which is not proportional to the deviation of machine voltage from the desired value. Commonly used non-proportional regulators will provide no corrective action when the machine terminal voltage varies from the desired value within a definite range, but will take corrective action when the voltage falls outside this range. Under normal operating conditions, the regulator will actually return the voltage to within the allowable limits, and will then cease corrective action until some external factor has again caused the voltage to exceed these limits. Consequently, the steady state regulation which can be obtained with this type is dependent entirely upon the limits within which the voltage may vary without corrective action by the regulator. The range between these limits is called the neutral zone and is sometimes known as the dead band.

One method of operation utilized in modern voltage regulators is the variation of an adjustable resistance usually located in the field circuit of the main exciter for the synchronous machine. The majority of regulators now in use operate on this principle. They adjust synchronous machine excitation by altering the exciter field circuit resistance to change the exciter armature voltage. The resistance may be varied by direct action of the regulator control element upon the variable resistance through mechanical linkages which connect the control element and resistance; or, indirectly by operation of a motor or

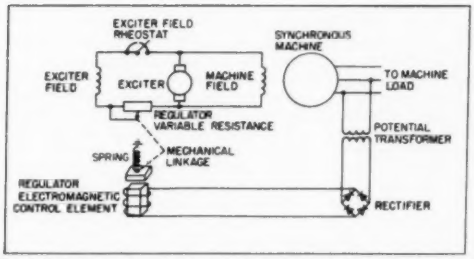


Fig. 4. Excitation system, direct-acting electro-mechanical voltage regulator

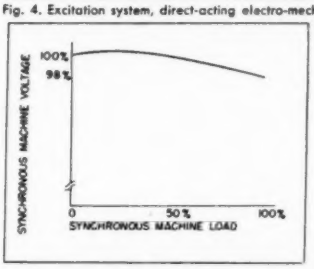


Fig. 5. Curve showing proportional regulator characteristics (Fig. 1)

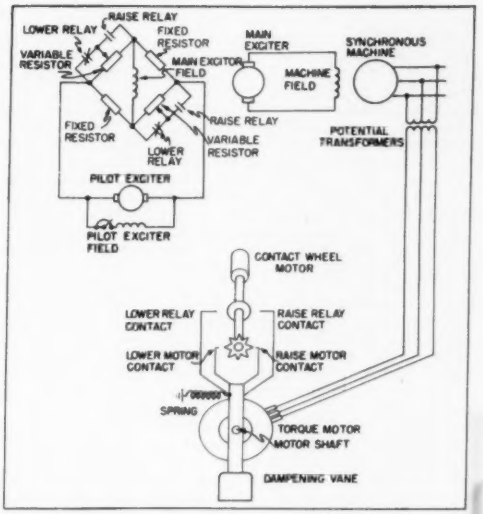


Fig. 6. (Right) Diagram of excitation system with indirect-acting type electro-mechanical voltage regulator (Fig. 2)

relays controlled by the regulator control element. The direct and indirect acting resistance type voltage regulators control the synchronous machine excitation in much the same way as an exciter field rheostat, except they operate automatically, and with far greater speeds than can be obtained by manual control.

A second type of regulator, which is rapidly increasing in importance, controls the voltage generated by a direct-current generator connected in series with the shunt field of a self-excited main exciter for a synchronous machine. By action of the regulator control element, the direct-current generator can apply a voltage in either direction in the exciter field circuit to increase or decrease exciter field current, and thereby control synchronous machine excitation. The direct-current machine is of a type which delivers a large amount of power with a relatively small quantity of input or excitation power; it is known as a rotary amplifier or amplidyne. The excitation of the amplidyne is controlled by a regulating circuit which determines the direction and magnitude of the amplidyne voltage in accordance with deviations of synchronous machine voltage from normal.

Regulator Design Classes

Voltage regulators may be divided into two general design classes; these are the electro-mechanical type, and the static type. Electro-mechanical regulators are comprised of a group or groups of moving members, the actions of which members are related by mechanical interconnection. They include such elements as electromagnets, armatures, links, pivots, and springs. Static regulators consist of a group or groups of static or stationary components, the actions of which are related by interconnection of the components in electrical circuits. These regulators include components such as transformers, reactors, capacitors, rectifiers, resistors, and electronic tubes. Electro-mechanical regulators are generally of the resistance type, and may be either proportional or non-proportional. Static regulators are usually associated with rotary amplifiers, and are always proportional regulators.

A direct acting, electro-mechanical resistance type regulator is shown in Fig. 1. The upper portion of the regulator is a variable resistance unit which consists of two stacks of carbon plates. The lower portion of the regulator includes an electro-magnet and an armature restrained by a spring, the armature being connected to the carbon stacks by a mechanical linkage. As the coil voltage of the electromagnet is changed, the magnetic attraction of the armature by the magnet will change, which will result in movement of the armature and the carbon stacks. Movement of the stacks will alter their effective resistance, so that an increase or decrease in coil voltage will produce stack movement giving increased or decreased stack resistance. Figure 4 shows how this regulator is used with a generator having a self-excited shunt exciter. The variable resistance element of the regulator is placed in series with the exciter shunt field. The regulator coil is connected to the terminals of the generator through a dry-disk type rectifier and a potential transformer. In this way, the d-c voltage applied to the coil is directly proportional to the generator voltage.

When the generator voltage increases above normal, the coil voltage will increase proportionately, causing an increase in the variable resistance, and a decrease in exciter field current and voltage. This will produce a decrease in generator excitation which will operate to reduce the generator voltage toward normal. A reduction in generator voltage below normal will give opposite results. The effect of the regulator upon the exciter is shown in Fig. 7. Variation of the regulator resistance will move the field circuit resistance line between the maximum resistance line, obtained with the variable resistance at a maximum value, and the minimum resistance line, obtained with the regulator resistance at a minimum value. The minimum exciter voltage obtainable is largely determined by the maximum resistance which the regulator can provide, and the maximum voltage by the combined resistance of the exciter shunt field and any necessary external resistance.

This regulator is a proportional type since a given deviation in generator voltage from the desired value produces a definite change in resistance, or corrective action. The regulator can only decrease the field circuit resistance as a result of a decrease in generator voltage, therefore, it follows that the generator voltage must steadily fall as load is applied in order to obtain the higher exciter voltages required for operation under increasingly greater loads. Consequently, the steady state terminal voltage of a synchronous machine controlled by a proportional voltage regulator will vary as an inverse function of the machine load or excitation requirements. These effects are illustrated in Fig. 5, where it may be seen that the generator voltage falls 2 per cent as the generator load is varied from no load to full load.

The control element of an indirect-acting, electro-mechanical, resistance-type regulator is shown in Fig. 2. It consists of a torque motor, two sets of

contacts, and a dampening mechanism. The torque motor closely resembles a squirrel cage induction motor in general construction. It has a stator winding which is connected to the synchronous machine potential transformer, and a rotor to which are attached a contact arm and restraining spring. The position of the contact arm is determined by the rotor torque as applied against the restraining spring, the torque being established by the magnitude of the voltage impressed upon the stator winding. If the voltage applied to the stator is increased, the rotor torque will increase, and the rotor will turn slightly against the spring; if great enough, this movement will close a contact which will energize the driving motor of a motor-operated rheostat to cause it to increase the rheostat resistance; if continued further, the rotor movement will result in the closing of a second contact which will energize a relay to increase the rheostat resistance to its maximum value. Opposite effects will result if the voltage applied to the torque motor is sufficiently decreased.

A schematic diagram of the regulator as used with a synchronous machine equipped with main and pilot exciters is shown in Fig. 6. The pilot exciter is operated at a constant voltage. A Wheatstone bridge rheostat is connected between the pilot exciter and the main exciter field. The rheostat driving motor is operated from a separate source of power, and is controlled by the raise and lower motor contacts of the regulator control element. If the machine terminal voltage should fall slightly below the value for which the regulator is adjusted, the raise motor contacts will intermittently close against the rotating serrated contact wheel, and will intermittently energize the rheostat motor to cause it to decrease the effective resistance of the rheostat and increase the main exciter field current, thereby increasing the machine excitation. If the voltage should fall to a sufficiently low value, the raise relay contact will close, and the raise relay will operate to instantly reduce the effective resistance of the rheostat to a minimum. This will act to increase the exciter field current and armature voltage to a maximum. These effects combine to increase the machine voltage so that the raise contacts will be disengaged, and the corrective action will be discontinued when the voltage has been returned to within allowable limits. The motor and relay control circuits have not been shown in Fig. 6 to avoid complication.

Under actual conditions, operation of the motor will correct for voltage deviations due to moderate changes in excitation requirements. The relays will only be operated when larger voltage deviations occur resulting from appreciable changes in excitation requirements, and under these circumstances, the relays may operate a number of times to maintain excitation at an average value approximating existing requirements. This will continue until the motor has brought the resistance within a range which will provide sufficient corrective action to return the voltage to a value that will not produce relay operation.

Since the effective resistance of the rheostat may be reduced to zero, the maximum voltage of the main exciter will be determined by its characteristics, and the pilot exciter voltage. The minimum main exciter voltage is dependent upon the rheostat design, which may be such that the exciter voltage can even be reversed.

The operating characteristics of this voltage regulator are shown in Fig. 8. The neutral zone is established by the limits within which it is desired to maintain the synchronous machine voltage under steady conditions over the normal range of the machine excitation requirements. For illustrative purposes, the neutral zone has been shown as 1 per cent of the desired voltage. The regulator will take no corrective action as long as the machine voltage remains within this zone; this is accomplished by adjusting the regulator control unit so that none of its contacts will close when the machine voltage varies within the allowable range. However, as soon as the voltage passes outside of the neutral zone, the regulator control unit will contact the front contact wheel. The rate at which corrective action is applied, but not the magnitude of the correction action, will be a function of the voltage deviation beyond the neutral zone, up to the point at which the rheostat motor is energized continuously. If the voltage deviates appreciably beyond this point, the control unit will energize the appropriate relay to cause maximum corrective action by suddenly changing the rheostat resistance to the maximum or minimum value. Therefore, the regulator is non-proportional in that it does not provide corrective action which is proportional in magnitude to voltage deviation, and also because if given sufficient opportunity, it will reduce the voltage deviation beyond the neutral zone to zero.

Static Voltage Regulators

A typical static type regulator is shown in Fig 3. The illustration is a rear view of a magnetic regulator. This device consists of transformers, reactors, resistors, capacitors and metallic rectifiers; a saturable reactor is the voltage sensitive element. These regulators are designed so that the principal adjustments may be made on one side of a steel supporting panel; the components and wiring are located on the opposite side. The rotary amplifier of the type used with these regulators is generally coupled to a squirrel cage induction driving motor. The rotary amplifier or amplidyne is commonly rated at 3 or 5 kw, even when the regulator is used with turbine generators rated over 100,000 kw.

Static regulator operating characteristics are illustrated in Fig. 9. When the a-c voltage is less than the desired value, the regulator will supply positive excitation to the amplidyne. When the a-c voltage is above

Fig. 7. Operational characteristics of the resistance-type voltage regulator which is shown in Fig. 1

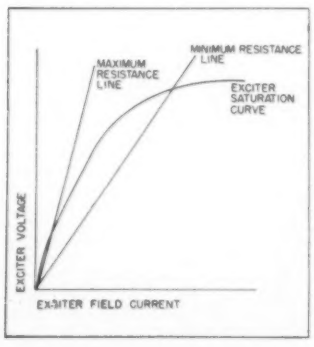


Fig. 8. Curve showing non-proportional regulator characteristics of regulator shown in Figs. 2 and 6

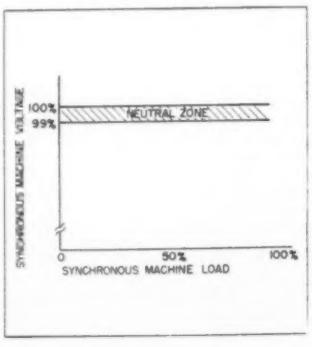
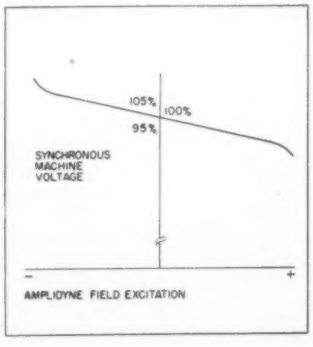


Fig. 9. Static regulator characteristics. Note how amplidyne is supplied plus or minus excitation



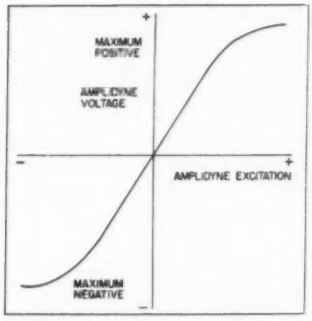


Fig. 10. Amplidyne characteristics. Armature voltage increases in direct proportion to field current

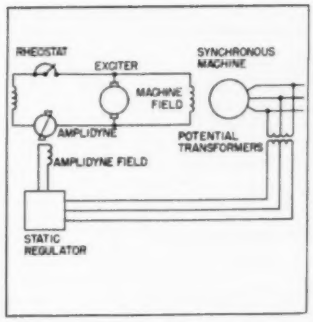


Fig. 11. Simplified diagram of excitation system with static-type voltage regulator and amplidyne

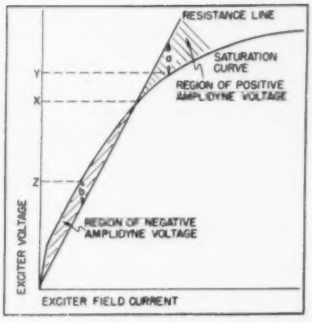


Fig. 12. Operation of static type voltage regulator showing effect of voltage applied by amplidyne

the desired value, the regulator will supply negative excitation to the amplidyne. Finally, when the a-c voltage is equal to the desired value, the regulator will supply zero excitation to the amplidyne.

A typical amplidyne characteristic is shown in Fig. 10. The armature voltage increases in direct proportion to the field current up to the point at which the machine starts to saturate. The direction of the armature voltage will depend upon the direction of the current flow through the control field. The excitation or control field power required by this machine is extremely small in comparison with its output rating, and is well within the capacity of the regulator with which it is associated.

A simplified diagram of a static voltage regulator in a synchronous machine excitation system is shown in Fig. 11. The static regulator is connected to the synchronous machine terminals, and controls the amplidyne which is in the exciter shunt field circuit. When the synchronous machine voltage decreases below the value for which the regulator is adjusted, the regulator will increase the amplidyne voltage in the positive direction so that it will increase the exciter shunt field current by adding to the exciter armature voltage applied to the field. This will increase the machine excitation to retard further decreases in voltage. If the machine voltage increases above the value which the regulator is adjusted to maintain, the control unit will increase the amplidyne voltage in the negative direction so that it will decrease the voltage applied to the exciter shunt field, and thereby decrease machine excitation and retard further increases in machine voltage.

The effect of the voltage applied by the amplidyne is indicated in Fig. 12, which represents an assumed saturation curve for the main exciter. The position of the resistance line is determined by the setting of the exciter field rheostat, and is selected so that at some particular synchronous machine load, the exciter voltage X, at the intersection of the resistance line with the saturation curve, will be just sufficient to maintain the machine terminal voltage at the desired value. Under this operating condition, the amplidyne voltage will be zero since no corrective action is required. If the synchronous machine load is increased, necessitating an increase in exciter voltage to Y to maintain the desired machine voltage, the amplidyne voltage will increase in the positive direction by the amount a. The sum of amplidyne voltage a and exciter voltage Y will be just sufficient to force a current through the exciter field which will produce exciter voltage Y. If the machine load should decrease below the value at which exciter X is required to produce the desired machine terminal voltage, the amplidyne will provide a negative voltage. With a machine load at which exciter voltage Z will maintain the desired machine voltage, amplidyne voltage b will appear in a negative direction, so that the difference between exciter voltage Z and voltage b is just sufficient to force a current through the exciter field which will produce voltage Z.

In general, the maximum amplidyne voltage required will be of the order of magnitude of 20 per cent of the exciter voltage under steady state operating conditions over the normal excitation range of the machine. The amplidyne may be capable of producing a voltage of three to five times this value, so that rapid changes in machine excitation can be obtained when required as a result of a system disturbance. The maximum obtainable exciter voltage is dependent upon the position of the field resistance line and the maximum voltage which can be produced by the amplidyne. Under proper operating conditions, this exciter voltage may be well above the rated voltage. This system will also permit reversal of exciter voltage.

Because a definite deviation of synchronous machine voltage from the desired value is required to obtain a corrective amplidyne voltage, the machine voltage will never be at exactly the desired value except when the required exciter voltage is the value represented by X. The regulator is, therefore, a proportional regulator, and has characteristics similar to those shown in Fig. 9.

Application of Various Types

Each of the regulators previously described possess features which make it particularly suitable for certain types of applications. The factors which influence the choice of a regulator for a particular installation are the rating of the synchronous machine, the type of load to be supplied by the machine, and the performance required of the regulator.

The direct-acting electro-mechanical regulator is commonly applied to high speed machines up to 25,000 kva and is more widely used than any other type. Because of the difficulty of designing large resistance elements and electro-magnetic control elements to directly control the larger resistance elements, it is usually impractical to build this type of regulator for use with the exciters required for larger machines. The regulator is compact and simple, and experience has demonstrated its reliability and excellent maintenance qualities. Fairly rapid speed of response, and the ability to maintain voltage within reasonable limits over the full load range of a machine, commonly within plus or minus one or two per cent of the desired value, make it well suited for most power generation applications. It is satisfactory for use where machine load changes are rapid, frequent, and large in proportion to machine rating, as well as for installations where loads are relatively constant or change gradually.

The indirect acting electro-mechanical regulator is satisfactory for applications involving machines which are too large for the direct acting type, and may be used with the largest machines built. Although it

(*Continued on page 112*)

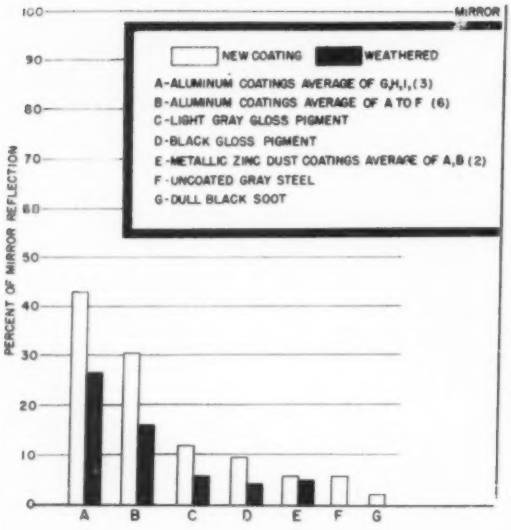


Fig. 1. Chart showing results of reflectivity tests described in text below

Table showing readings of light meter in test of Fig. 2, as percentages of mirror reflection, for panels with new coatings and after weathering

Panel No.	Finish	Readings in Milliamperes New Coating	After Weathering
A	Mirror, standard	1.000	1.000 *
1	Aluminum, No. A	0.290	0.143
2	Aluminum, No. B	0.315	0.137
3	Aluminum, No. C	0.355	discarded
4	Aluminum, No. D	0.353	discarded
5	Aluminum, No. E	0.295	0.167
6	Aluminum, No. F	0.280	0.190
7	Aluminum, No. G	0.403	0.273
8	Aluminum, No. H	0.480	0.272
9	Aluminum, No. I	0.397	0.267
10	Light gray pigment, glossy	0.127	0.060
11	Black pigment, high gloss	0.100	0.042
B	Bare hot rolled steel (gray)	0.060	not weathered
C	Zinc dust pigment, No. A	0.060	0.050
D	Zinc dust pigment, No. B	0.060	0.057
E	Soot, dull black	0.020	not weathered

* Mirror standard was, of course, not weathered, but is placed at the head of the weathered column for the unit standard.

In Your Power Plant Painting Program, Make Simple Reflection Tests

In many power plant painting jobs, absorption or reflection of heat from surfaces of tanks, transformers are important as well as surface protection. Here are ways to make simple tests, without elaborate test facilities, to guide in selecting best colors and types of paint

By L. G. JONES

IN AN ARTICLE, in the October issue, a simple method of testing industrial paints to be used for coating steel structures was discussed. Its purpose was to present a quick method of selecting a paint that would give good weather and corrosion resistance, preferably with the application of one coat.

But the problem of maximum protection against heat absorption often arises as well. It may be for the protection of containers of gasoline, propane, solvents, or other vaporable liquids, to reduce tank pressures under the hot summer sun. Or, conversely, we may want to increase the heat radiation from surfaces like those of steam radiators, electric transformers, cooling equipment and so on. Surface paint colors are important in the retention of heat during cold winter, such as in heated fuel oil tanks, steam systems, and the like, in order to minimize heat losses by radiation to the cooler atmospheres. In many power plant and industrial applications, careful paint selection may save money.

It might be worth while to run a few simple tests in advance, tests that require no laboratory facilities, no special equipment, and no trained technicians. One can generally assume that a surface that reflects most of the heat rays impinging upon it will absorb the least heat radiation. A high-gloss surface will reflect more heat rays than a dull one. A metallic coating will reflect more heat than a pigment-base paint and the fact that calorimeters are made with bright, shiny metallic finishes provides evidence. A dark color will generally absorb more heat than a light finish.

What Is Reflectivity?

Often other properties must be given consideration along with heat reflection characteristics. Frequently these may be given priority. Company policies, uniform color schemes, appearance, health reasons, individual preferences, and the like, may dictate the choice of color.

When such broad policies are involved, compromises in color schemes can be made that will reduce ultimate efficiencies very little. A fairly wide range of colors will scarcely affect heat values. Theoretical physics may take second place to medical and artistic values.

Consider the property of reflectivity. The case in hand was the selection of the proper paint for a large number of 20,000-gal propane storage tanks. These all were shipped into the plant finished with a red-lead ground coat. It was known that in the hot summer the sun's rays might, unless a high reflective surface coating was placed over the heat absorbent red dull ground coat, boost the vapor pressure of the liquid as much as 50 psi. Relief valves might pop and vapors be lost.

Various paint vendors recommended different coatings. One manufacturer insisted that a high-gloss light gray pigment paint would be superior to aluminum paint. His pigment paint would be self-cleaning (chalking) and retain its light reflective color indefinitely, whereas aluminum paint would pick up soot from the nearby railroad

Modern power plant practice demands a water conditioning program that produces only the ultimate in trouble-free and efficient boiler operation.

External softening and the use of conventional inorganic treatments are recognized requisites. However, the supplementary use of organic agents may well assure the difference between long, uninterrupted operation and frequent boiler outages due to scale and sludge formations.

Take the case, for example, of a large electrical manufacturer, who called in Betz 14 years ago to treat its new power plant. This plant operates at 900 pounds pressure with 50% make-up polluted river water. Betz recommended the use of organic agents to supplement the external softening and inorganic treatment.

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and factory smokestacks, and soon form dull gray or dark, rough, poorly-reflective surface.

Yet all the gasoline and vaporable storage tanks in the area were painted with aluminum coating. Conversations with their maintenance men indicated convictions for the aluminum paint. With such doubts raised, we felt it best to find out for ourselves.

How Make Reflective Tests?

The equipment was set up as illustrated in Fig. 2. A beam of light from a Burton Model A microscope lamp was directed at an angle of 45 deg downward to an exposed portion of a piece of steel sheet coated with the paint under test. A microscope lamp happened to be available, but a beamed flashlight would have worked.

The light beam reflected from the panel rose at a 45-deg angle to be received on a Weston photographic photocell light meter that read in milliamperes. The steel panel lying on the table was covered with a dull black cardboard in which was cut a $1\frac{1}{2}$-in. square hole that served as the target for the light beam. The various panels to be tested were slid under the cardboard aperture for test.

A single-strength silvered gloss mirror was selected as our standard for comparison with all coatings. This mirror was slid under the cardboard aperture before and after each panel was tested, in order to check and set the amperage of the light meter. The reading on the light meter was set at 1.000 ma (milliamperes) for the mirror. The reading for each paint panel then became a simple percentage value of mirror standard.

Two sets of tests were run on the panels. One series of reflective tests was run on the freshly painted panels, each consisting of one coat applied on all of them in similar fashion, as outlined in the previous article. The panels were then weathered for two weeks by exposure to an arc light, wetting with a tap water spray and then dipping into a coal-dust mixture. This was done each day for two weeks. The purpose of this weathering procedure was to try to simulate exposure to the industrial atmosphere of the plant, with some acceleration. Standard weatherometer exposures could ideally be used for this purpose.

Several special panels were prepared to check the method of testing. One was coated with black carbon soot from a burning candle in order to determine the efficacy of the black surroundings of the aperture. Would the dull black soot read zero on the test light meter as contrasted with 1.000 for the silvered mirror? A bare gray, hot-rolled steel panel was also tested without any coating, panel B. Along with the aluminum paints, one vendor recommended a highly corrosion-resistant zinc-base paint. This was a metallic coating in principle albeit the zinc was in fine dust form similar to the aluminum pigments. The zinc coatings had a dull gray color and are indicated as panels C and D in the table.

Along with the light gray gloss paint recommended so highly by one vendor, panel 10, a brilliant, glossy-black paint was tried in order to ascertain the effect of the glossiness of the coating as contrasted with the light gray glossy paint and with the dull black of the sooted zero panel. This glossy black panel is numbered 11 and is also shown in Figs 3 and 4, since this panel was weathered along with the light gray panel. This panel was deemed significant in consideration of pigment paints for transformers, cooling equipment, and radiators, for which many different colors had been suggested.

The numbered panels used are similar to those used as examples in the previous article of this series in the water tests. Figure 3 shows these panels before weathering and Fig. 4 after weathering.

What the Tests Showed

The answers were quite clear. Aluminum finishes G, H and I, panels 7, 8 and 9, give higher reflections than any other samples tested, both before and after weathering. Figure 1 better illustrates the surprising differences discovered among the various types of paints and even among the similar aluminum paints. The author is not a paint expert and offers no comment on the results, which were his sole concern. The aluminum coating was recommended as the preferred finish for the propane tanks. Sources G, H and I were suggested as the preferred sources from the point of view of reflectivity. Source H rested the highest.

There are always possibilities of error in single simple tests of this type that were completed in two weeks. Actually the tests of reflectivity was a matter of but a couple of hours. When one realizes the many months of tests that paint manufacturers put their products through, it may be that the above test may not be fair. Perhaps the method had faults. The vast difference between vendors' claims and these results, in a few cases, may raise a doubt. Could the continued investments in the general policy of painting such important equipment be based upon such tests?

On the basis of these considerations and to assure no errors of testing or evaluation, we decided to run some actual heat absorption tests on these panels, using actual heat sources, thermometers not light meters, etc. These tests will be discussed in a subsequent article. The new results did check. The reflection tests were corroborated by the heat absorption tests, in their inverted reciprocal proportions.

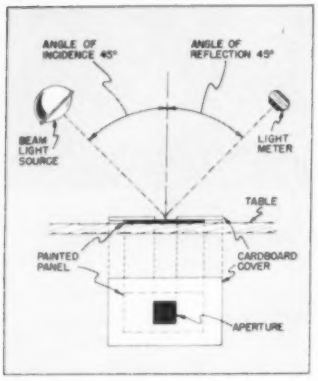

Fig. 2. Simple equipment for paint reflectivity tests

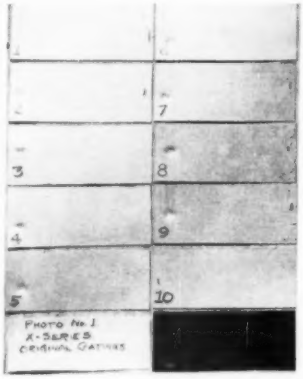

Fig. 3. Panels as originally painted before tests

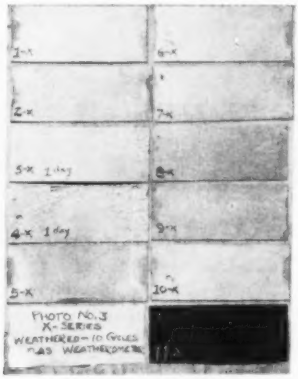

Fig. 4. Test panels after weathering and dusting

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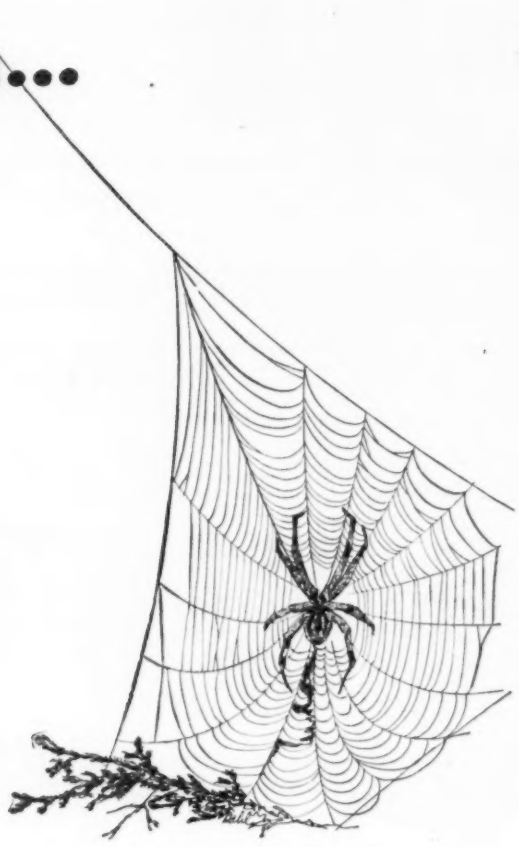

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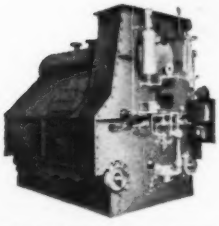

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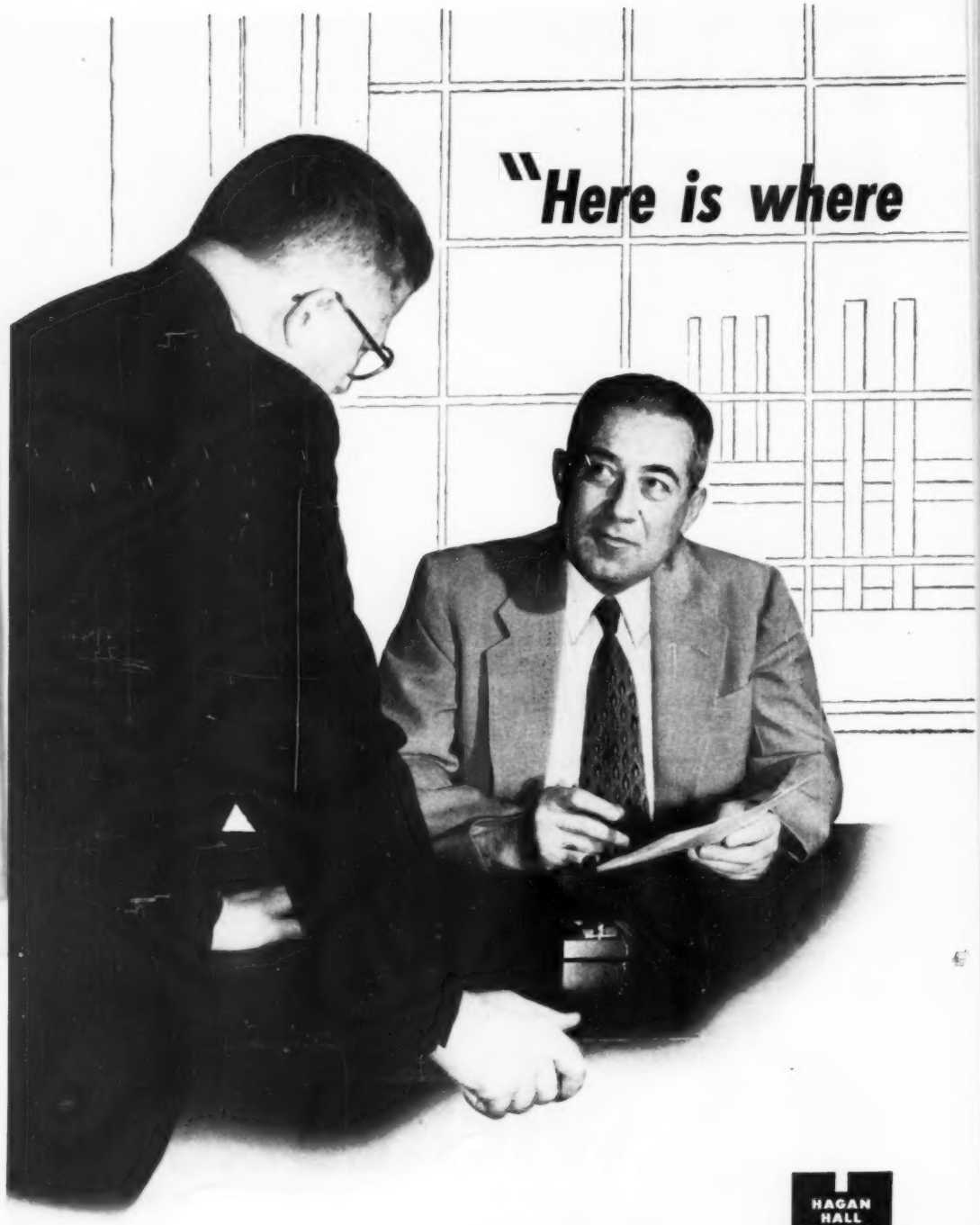

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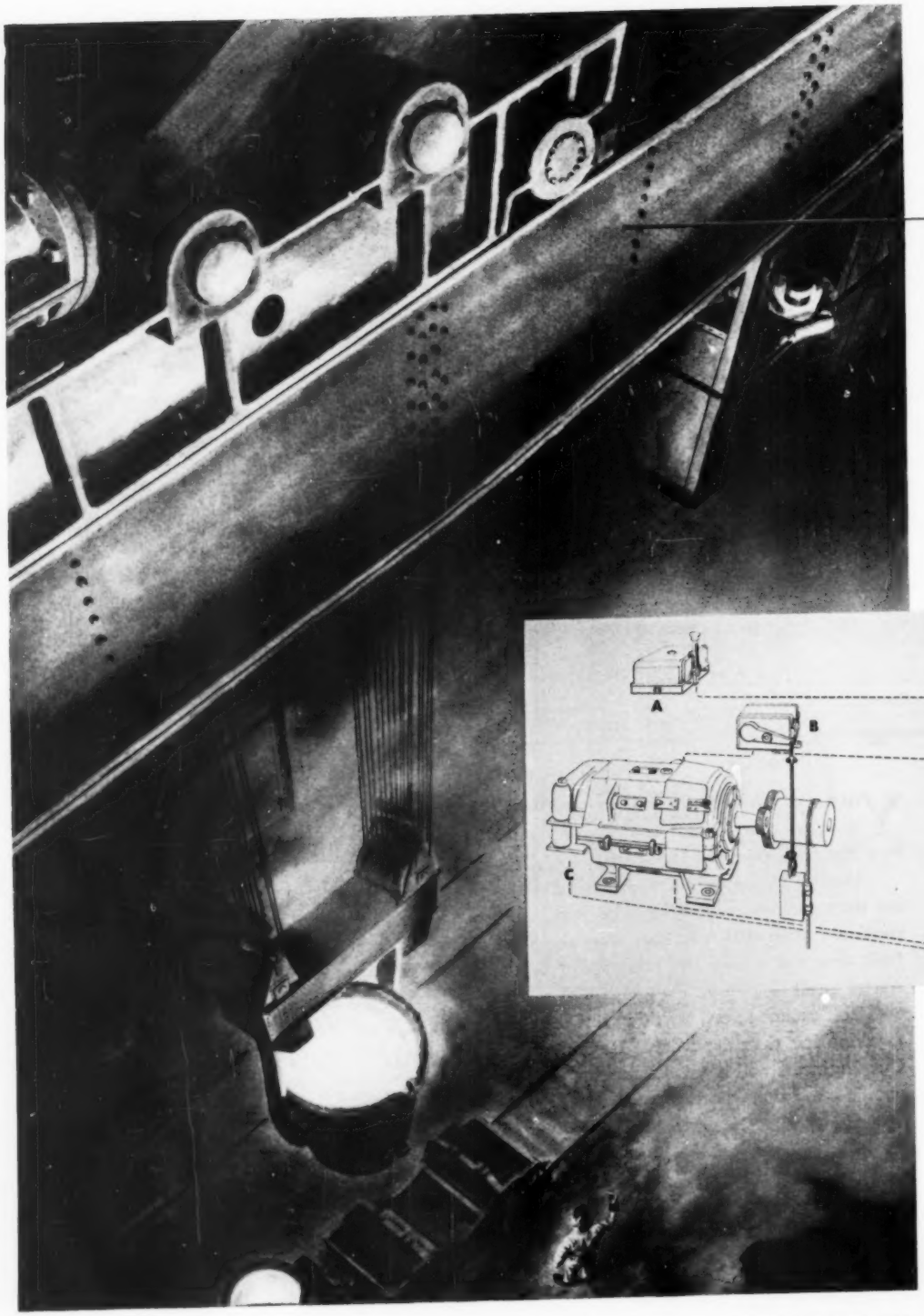
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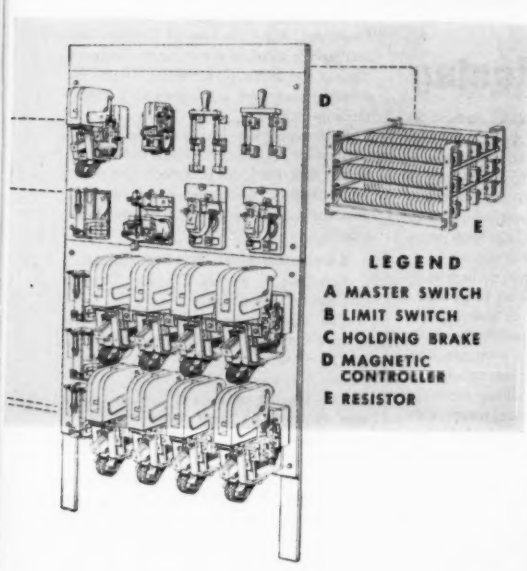

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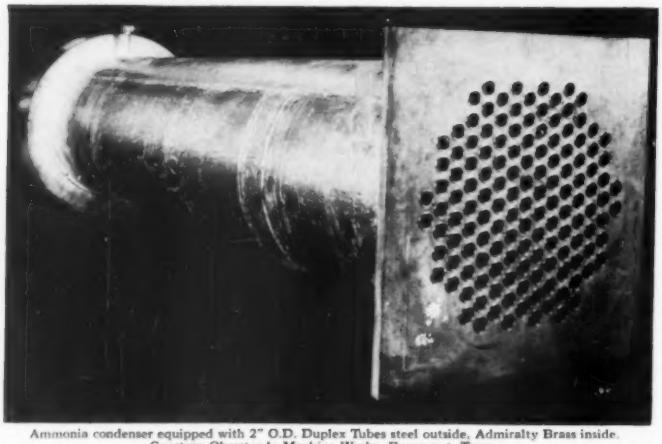

Ammonia condenser equipped with 2" O.D. Duplex Tubes steel outside, Admiralty Brass inside. Courtesy Ohmsteade Machine Works, Beaumont, Texas.

Refrigeration and Air Conditioning

Mechanical refrigeration and air conditioning have widely penetrated domestic, industrial, processing, chemical, and refining fields bringing many problems involving the handling of corrosive gases and liquids.

Freon and Methyl Chloride Refrigerants

For Freon or methyl chloride refrigerants that are in a dry condition, copper and copper-base alloys have proved to be most satisfactory from the standpoint of corrosion resistance and long life. On the cooling water side, arsenical Admiralty 30 stands up well in contact with low velocity sea water. On the fresh water side or where air is the cooling medium, copper is very satisfactory.

If there is a possibility of impingement corrosion because of high sea water velocities, Aluminum Brass 54 is superior to Admiralty 30. For extremely high sea water velocities one of the Cupro Nickel alloys is recommended.

Ammonia Refrigerant

Although dry ammonia gas is not corrosive to many metals and alloys, the corrosiveness of liquid or gaseous ammonia is greatly increased by the presence of water and oxygen or air.

Furthermore, ammonia combined with moisture and air is one of the most important factors contributing to stress corrosion cracking of many copper-base alloys. Stress corrosion cracking is a highly localized form of attack resulting in deep, narrow, penetrating cracks in stressed metals.

On the other hand, low carbon steel tubes are very resistant to both anhydrous and moist, liquid or gaseous ammonia. This explains their wide use in the construction of equipment handling ammonia. However, steel tubes and pipes are subject to corrosion from the brine, sea water or fresh water side. This shortcoming can easily be overcome through the use of Duplex Tubing, consisting of copper or copper-base alloy to the water side and low carbon steel to the ammonia side.

Duplex Tubes

Because of the above, Duplex tubes are finding wide application for ammonia refrigeration and for equipment producing ammonia and its compounds.

The most popular Duplex combinations are low carbon steel to the ammonia side, with Copper, Admiralty 30, or Red Brass 85 to circulating fresh water from rivers, lakes, ponds and wells. Where sea water is used for cooling purposes, 90-10 Cupro Nickel 510, 80-20 Cupro Nickel 520, 70-30 Cupro Nickel 531 (when available), Duronze IV 53 (Arsenical Aluminum Bronze), Aluminum Brass 54 and Admiralty are preferred to copper because of their greater corrosion resistance. When the velocity of the sea water is comparatively high, Cupro Nickel, Duronze IV and Aluminum Brass are preferred because of their greater resistance to impingement corrosion.

Duplex Tubes Improve Heat Transfer Characteristics

Experiments have shown that Duplex tubes made up of steel and copper or a copper-base alloy show superior heat transfer characteristics than straight steel tubes. Replacement of corroded steel tubes in ammonia condensers with steel/copper Duplex tubes has shown up to 25% reduction in power costs and require fewer tube cleanings. Also the use of Duplex has resulted in smaller size heat exchangers having the same total heat transfer as a larger size unit equipped with regular steel tubes.

It is especially important to have a tight joint in any ammonia system. A small leak may contaminate the cooling water or brine, thus accelerating corrosion of the copper or copper-base alloy.

Advantages of Duplex Tubes

Briefly the use of Duplex Tubing has many advantages:

(1) They do an excellent job where a dual corrosion problem is involved.

(2) Over a period of time, maintenance is considerably reduced.

(3) During periods of copper shortage, copper has been conserved or its use extended through the use of Duplex Tubing.

(4) Fine for untreated raw waters which are corrosive towards low carbon steels and stainless steels.

(5) Give greater corrosion resistance to treated waters.

(6) Frequently give markedly improved heat transfer characteristics.

(7) Can sometimes use a thinner wall Duplex tube than that of a regular tube.

Much information on Duplex tubes is given in Bridgeport's "Duplex Tubing Technical Bulletin No. 1950". Contact our nearest sales office for your tube requirements. (9083)

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For more data circle 546 on Post Card

Large Power Producer Meets Demands up to 400,000 lb per hour with Evaporation Rate of 12.8

"During the many years we have been generating power at Scovill Manufacturing Company, Waterbury, Conn.," says Leo Niekerk, Power Plant Chief Engineer, "we have evolved a general philosophy for power plant operation: buy the best equipment available, then operate and maintain it in the most intelligent way possible. We have two power houses—the West Power House containing one 500 kw vertical turbine, one 3,000 kw condensing turbine generator, and two 600 hp oil-fired 150 psi boilers on standby; and the East Power House containing three 3500 kw condensing turbines, one 5,000 kw topping turbine, six 600 hp stoker-fired 250 psi boilers and, handling most of the load, two 660 psi oil or pulverized coal-fired steam generating units rated at 225,000 lb/hr and 150,000 lb/hr."

fuel handling

"Coal from railroad cars is transferred to overhead bunkers by a conveyor system. Fly ash from dust collectors is removed by conveyor ash handling system and discharged through an outside silo. Oil is stored in two 150,000 gal. tanks and fed by gravity to the fuel oil pumps in the basement."

combustion control

"When we installed our Boiler #1 in 1940 we selected Hays Combustion Control. We were so pleased with its operation during the next six years that when we installed Boiler #2 in 1946 we again specified Hays Combustion Control. Each boiler has its own Hays panel containing a complete complement of modern boiler room instruments and controls. Currently we are meeting steam demands up to 400,000 lb per hour (with load swings as high as 60,000 to 70,000 lb per hour) while achieving an evaporation rate of 12.8, a fuel cost per kw of $.0049, and a cost per thousand pounds of steam of $.706. No small part of the credit for the versatility and efficiency of our operations should go to the Hays Combustion Control System. Maintenance expense on the control system has been negligible.

The above story is a condensation of a completely illustrated case history on the power plant operation of Scovill Manufacturing Company. Write for Bulletin R-8, available free from The Hays Corporation, Michigan City, Ind.

When You Think of

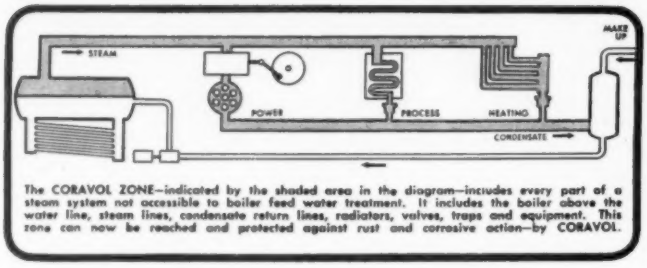
CORROSION PROTECTION for your STEAM SYSTEM

Think of

CORAVOL

(The Original* AMINE PROCESS)

Because CORAVOL Circulates to Control Corrosion



The CORAVOL ZONE—indicated by the shaded area in the diagram—includes every part of a steam system not accessible to boiler feed water treatment. It includes the boiler above the water line, steam lines, condensate return lines, radiators, valves, traps and equipment. This zone can now be reached and protected against rust and corrosive action—by CORAVOL.

CORAVOL IS PART OF A COMPLETE TECHNICAL SERVICE which provides special chemical formulas for . . . boiler feed water . . . foam prevention . . . hot water supply . . . refrigerating brine . . . cooling and condenser water . . . rapid scale removal . . . coagulation . . . algae control . . . fuel oil supply . . . soot removal.

CORAVOL circulating throughout your steam system protects it from corrosive attack. **CORAVOL** saves costly pipe repairs and replacements—maintenance labor—hours and days of shutdown loss. **CORAVOL** cleans out clogging rust deposits, improving heat transfer, restoring original capacity of lines and efficiency of valves and traps.

CORAVOL, the original* amine process, has the flexibility that lets it conform to each individual need. The **CORAVOL** *you* will use is formulated to do the best protective job under your own plant conditions.

*The use of **CORAVOL** in steam systems is covered by U. S. Patent No. 2033024. The Western Chemical Co., owner of this patent, grants licenses under which volatile AMINES purchased from other sources may be used in steam systems upon payment of royalty to Western Chemical Co.

Chemical Water Treatment

WESTERN CHEMICAL COMPANY

717 Washington Street
Kansas City 6, Missouri

MAIL COUPON TODAY for
Complete Data about the CORAVOL Process

Western Chemical Company,
717 Washington Street,
Kansas City 6, Missouri

Send me full information about CORAVOL.

NAME_____

FIRM_____

ADDRESS_____

CITY_____ ZONE_____

STATE_____

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KANAWHA AND MUSKINGUM

(Continued from page 62)

amplidyne-type voltage regulators.

Conventional aluminum bus structures will connect 18,000-v terminals, necessitated by large size of generating units, directly to three-phase power transformers, stepping up to 132 kv. Three-phase auxiliary transformers will be connected to leads of each of the generator windings. These transformers will feed auxiliary bus sections, each of which will have an alternate power supply from a three-phase transformer stepping down from the 132-kv system. Major motor drives will be accommodated on these buses; smaller 550-v motors will be served from buses fed by three-phase transformers connected to the main auxiliary buses. Flexibility of operation and emergency sources are provided in all cases.

Three main power transformers, forced air and forced oil cooled, will be provided for each unit. They will be bussed on the 132-kv side and then connected to the double-bus 132-kv yard through two oil circuit breakers which can also serve as a bus tie. Initially, five 132-kv feeders will be employed; each with a single breaker with selector switches to the two buses and a bypass switch to one.

Provision will be made in the switchyard for installing a 330-kv double-bus system to take the output of future units, with a large transformer bank for tying between 132- and 330-kv buses. To be connected with AG&E system's supervoltage network now under construction.

In this respect Muskingum River will be similar in arrangement to Kanawha River, except that only one of the two initial units will be connected to the 132-kv bus. Second will be stepped up to 330-kv through a bank of single-phase transformers.

"SIZE CONSIST"

(Continued from page 65)

The coarser coal mining crushing operations might be compared to the finer output of boiler plant pulverizers. Theo. James [4], in plotting many sieve tests on a battery of eight pulverizers, charted on empirical relationship between various sizes of particles produced in his pulverizer operations. His curves are illustrated in Fig. 3. He also developed equations relating various sizes within the aggregate for given general conditions. He believes that size relationships do exist. From the curves, this general formulations would be:

$$W = X + Z$$

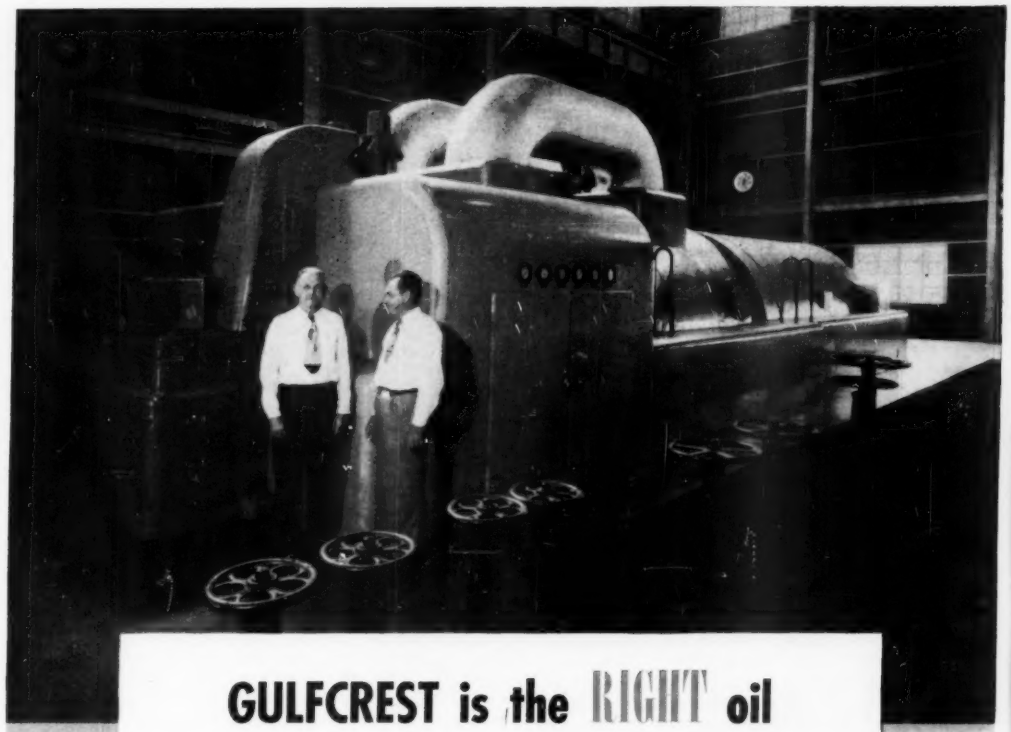
Drawing a vertical line at any operating point, say 50 per cent on the bottom scale, the actual relationship would figure:

$$71 = 21 + 50$$

For the total aggregate relationship,

[4] *Power Plant Engineering*, Feb. 15, 1932.

Typical of the many recently installed steam turbines lubricated with Gulfcrest Oil: 40,000 kw. Allis-Chalmers turbine at the Riverside Station of Gulf States Utilities, Lake Charles, La.



GULFCREST is the RIGHT oil for every steam turbine

the RIGHT base stock, Alchlor-processed
the RIGHT combination and concentration of additives
the RIGHT background of performance

Gulfcrest Oil has a background of successful performance in every type and make of steam turbogenerator.

In many of these installations the original charge of Gulfcrest has been in service more than 10 years with no significant change in its original characteristics, and with neutralization numbers always remarkably low and safe.

To get this kind of lubrication for your turbine, call in a Gulf Sales Engineer and ask him to recommend the proper grade of this superior oil for your turbine. Write, wire, or phone your nearest Gulf office today.

Gulf Oil Corporation · Gulf Refining Company
Pittsburgh 30, Pennsylvania

GULF SERVES INDUSTRY

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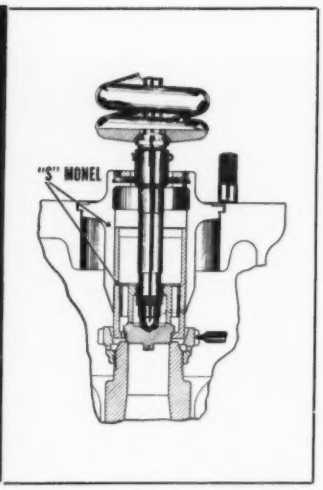
'S' Monel...

FOR RESISTANCE TO GALLING AND EXTRA HARDNESS AT HIGH TEMPERATURES



"Consolidated" Safety Valves like this have guide sections of extra hard "S" Monel. Manning, Maxwell & Moore, Inc., standardized on "S" Monel after extensive tests under simulated operating conditions. All proved "S" Monel an outstanding metal for resistance to galling and seizing.

Are you looking for a casting alloy for parts subject to high stress and severe friction under corrosive conditions?

Then take a look at "S" Monel.

"S" Monel is one of the hardest and strongest of the non-ferrous casting alloys.

Its coefficient of expansion closely matches that of carbon steel to give excellent service where clearances are small and operating temperatures high.

"S" Monel retains its hardness at elevated temperatures. It resists galling under severe conditions, even where lubrication is poor.

And because of its hardness it is highly resistant to abrasion and erosion.

It can be machined as cast. For extensive machining the casting may first be annealed and later age-hardened to develop its maximum hardness. It is not recommended for welding.

You'll find "S" Monel used as the guiding parts in safety valves, in valve discs and seats, impellers, wearing rings, bushings, sleeves, ejector nozzles and pump liners.

"S" Monel has helped many manufacturers in solving their metal selection problems.

Take for instance the problem of Manning, Maxwell & Moore, Inc.

They wanted a valve trim material that would hold up in the "Consolidated" Safety Valves.

The material had to be able to resist galling and seizing at high temperatures.

Many alloys were tested in combination with themselves and with other alloys, and "S" Monel consistently showed superior anti-galling properties. Now "S" Monel has been made the standard for the guiding sections of their high temperature "Consolidated" Safety Valves.

For more information on "S" Monel, write to Inco's Technical Service Section. They'll be glad to supply you with information and assistance.

Mechanical Properties of "S" Monel*

(Annealed and Age-hardened)

Yield Point	80-115,000 psi
Tensile Strength	120-145,000 psi
Elongation in 2-in.	4-1%
Hardness (Brinell)	300-375
Coefficient of Thermal Expansion (32°-212°F.) in./in/°F.	0000068

Hardness of "S" Monel at Elevated Temperatures*

(As-cast condition)

Temperature, °F.	Brinell Hardness
Room	321
700	321
800	311
900	311
1000	321
1050	335
1100	293

*Average properties—not to be used for specification.

THE INTERNATIONAL NICKEL COMPANY, INC.

67 Wall Street, New York 5, N. Y.

Inco Nickel Alloys

MONEL® • "R"® MONEL • "K"® MONEL • "KR"® MONEL
"S"® MONEL • NICKEL • LOW CARBON NICKEL • DURANICKEL®
INCONEL® • INCONEL "X"® • INCOLOY • NIMONICS®

For more data circle 542 on Post Card

"SIZE CONSIST"

(Continued)

We have the following equations:

$$W + X = W + X + Z$$
$$29 + 71 = 29 + 21 + 50$$

Mr. James' work was done on fine mesh screen sizes, 100 and 200 mesh for A and B screens respectively.

It seems to the author that standards and specifications could be developed that would fit various areas of the coal industry, as groups with their different kinds of coal, thereby accommodating the economic capabilities of these coal producing plants, in coordination rather than competition. Coal users would profit by such accommodation in better prices and supplies of such "premium tailored" coals. Research efforts can well be put forth along these lines especially by designers of coal firing equipment, leading to standardization of coal size consists.

CONDENSER TUBE JOINTS

(Continued from page 67)

since one end of the tube has been cold worked; and, in order to remove the tube, the expanded and belled end must be collapsed or drilled out. In the expanded-packed combination, therefore, the packing box serves only to handle differential expansion.

Efforts have been made to protect the expanded tube inlet from erosion. The most successful of these consists of inserting short streamlined pieces in the tube inlets. These pieces, known as tube inserts or flowrites, are installed with a bitumastic paint to keep them in place and can be removed when worn out and new pieces installed. They should be made of the same material as the tube to prevent electrolysis, or of some electrically-inert material like plastic.*

How to Remove Tubes

Method of tube removal completely depends on the type of tube joint involved. Many ingenious tools have been developed to accomplish tube removal. Most of them were developed in the field, for the specific conditions of a particular job, by maintenance gang foremen. Only in recent years have standard tube removal tools appeared on the market.

It is obvious that the only way to remove welded tubes is to drill out the ends. If the exchanger is large, one tube sheet is dismantled after drilling and the tubes pulled clear of the shell. The drill should be of a special type with a pilot that fits the inside diameter of the tube. The pilot centers the drill so that the tube sheet holes are not enlarged. Soldered tubes can be drilled out or if the exchanger is small, the tube sheets heated to melt the solder and thus free the tube.

* *Editor's Note:* — See also Condenser Lined with Neoprene, POWER ENGINEERING, October, 1951.

DRAFT FANS
GO on GREEN
Another Utility Job for Green Fans!
• Two Induced Draft Fans, each 198,000 cfm; 300°F stack gas at 15" static pressure.
• And special features include: radial tip blades, erosion-resistant wheels, control type inlet dampers, air-cooled bearing for outdoor service.

This installation, located in the South, adds to the mounting evidence that Green Draft Fans are very much in the boiler plant picture, both utility and industrial... evidence that they are high on the specification lists of leading consulting engineering firms and on the owners' lists of acceptable equipment.

There are numerous things about Green Induced and Forced Draft Fans that make them desirable auxiliary equipment for any boiler. We suggest that you have the basic facts at hand when you start planning for *your* fans. Send for our Bulletin 168 and in writing, tell us about your requirements.

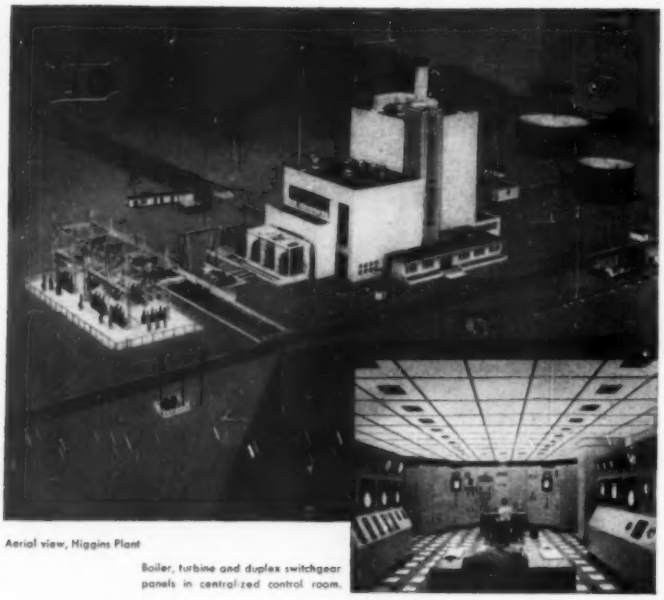
THE GREEN *Fuel Economizer* COMPANY INC.

- Economizers
- Fans
- Air Heaters
- Cinder traps
- Aerodyne Dust Collectors

BEACON 3, NEW YORK

Photo above shows the Green ID Fans being installed in the Chesterfield Power Station Extension of the Virginia Electric and Power Co., at Drewrys Bluff, Virginia.

For more data circle 550 on Post Card



Aerial view, Higgins Plant

Boiler, turbine and duplex switchgear panels in centralized control room.

Engineering & Construction

A SINGLE RESPONSIBILITY

Higgins Plant, Booth Point, Florida, is the leading generating station of Florida Power Corporation. The first unit, of 44,000 kilowatt capacity, supplies electric power to take care of present industrial, commercial and residential load requirements.

Station design, based on unit boiler-turbine arrangement, provides for economical future expansion. Two additional units will increase station capacity to 132,000 kilowatts to meet western Florida's rapidly growing power needs.

The complete unit—designed, engineered and constructed by Kuljian under a *single* contract—was completed six months ahead of schedule, for less than estimated cost.

The **Kuljian** *Corporation*

ENGINEERS • CONSTRUCTORS

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CONDENSER TUBE JOINTS, cont'd.

Removing Expanded Tubes: — Expanded tube ends present problems which depend on the type of exchanger construction. If of removable bundle design, the bundle is pulled from the shell and the tubes may be cut behind one of the sheets with a pneumatically powered chisel. The sheet is dismantled and the tubes are driven from the other tube sheet with a pneumatically powered tube driver. The driver is simply a two-step plug; the small end acts as a pilot in the tube, the large end is machined to the outside diameter of the tube. With the tubes driven from the sheet, they can be pulled through the baffle assembly.

In large bundles, the chisel can only reach the outer lines of tubes. Three other methods are available. The tube ends can be drilled as for welded tubes; the tube ends can be split and collapsed with an oyster knife, Fig. 4; or a tube cutter can be used. The latter is a more recent development, in which a slotted pilot is inserted in the tube and a linkage arrangement forces a cutter bit against the inside wall surface while the bit is rotated.

Drilling tube ends is a slow process and should be done only where no alternative exists as in the case of welded tubes.

Oyster Knife Method: — The oyster knife is forced between the tube wall and tube sheet. As it is advanced by pneumatic hammer, the vertical cutting edge slips the tube and rolls up the edges, collapsing the tube from the wall. Inexperienced men should never be allowed to use the oyster knife, because one mistake may ruin the tube sheet. Correctly used by experienced personnel, the oyster knife is effective and very fast. Advantage over the tube cutter or chisel is that the tube sheet is not left with tube ends to be removed later.

If the exchanger is of the fixed-tube-sheet type, as in condenser work, the removal method depends on whether the tubes are expanded both ends, packed both ends or expanded and packed.

For exchangers packed both ends with ferrules, a special wrench unscrews the ferrules after which a packing removal tool is fitted over the tube end. The tool has cutting edges, which cut away the fibre, metallic, or corset lace, as it is rotated. The tube is now free to be pulled out.

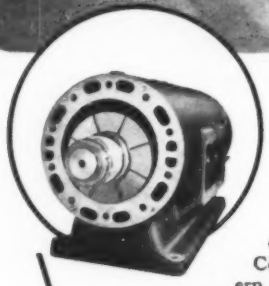
If one tube end is belled as in Fig. 1B, the bell must be machined off before the packing can be removed.

For exchangers rolled and packed, the packing is cut away at the outlet end, as described above; the bell is machined off the inlet end and the tube then driven, or oyster knifed, from the expanded inlet end tube sheet. The tube is now free to be withdrawn through the empty pack-

If better valves
could be made,
POWELL would make them
This is no idle boast because, for more than a century, Powell has been satisfying the demands of industry for the best valves it is possible to produce. As a result, Powell Valves have an enviable reputation for dependable service, long life and minimum maintenance.
The Wm. Powell Company
Cincinnati 22, Ohio
Fig. 6003 W. E. 600-pound Cast Steel O. S. & Y. Gate Valve with welding ends.
POWELL
BRONZE, IRON, STEEL AND CORROSION-RESISTING VALVES
DEPENDABLE VALVES
SINCE 1846

FULLER ROTARY AIR COMPRESSORS

WORK FOR WESTERN ELECTRIC



Long periods of continuous operation don't overtax these Fuller Compressors at Western Electric Co. plant at Indianapolis, Ind., where two 3300 cfm. two-stage duplex units and one 1665 cfm two-stage single unit supply all plant needs at 100 psig.

Endurance, plus efficiency, are results of the rotary principle employed in these compressors. Elimination of reciprocating parts does away with flow pulsations, cuts down on vibration and need for continual take-up of bearings. Another feature of interest to cost-conscious engineers is the limited maintenance required by Fuller Rotary Compressors—rotor, blades, and bearings are the only moving parts.

Because these compressors do not require valves, top overall efficiency is maintained at all times—no capacity is lost around leaking valves, no time lost to grind seats. Fuller Compressors do not require driving mechanisms nor speed change gears—they are designed to operate at common electric motor and internal combustion engine speeds.

You'll find these compressors stay on the job, operate with sustained high efficiency and require little maintenance. If your plant requires air in volume, it will pay you to investigate the advantages of Fuller Rotary Compressors. A Fuller engineer will discuss them with you.

Fuller

FULLER COMPANY, Catasauqua, Pa.
Chicago 3 • 120 So. LaSalle St.
San Francisco 4 • 420 Chancery Bldg.

DRY MATERIAL CONVEYING SYSTEMS AND COOLERS—
COMPRESSORS AND VACUUM PUMPS—
FEEDERS AND ASSOCIATED EQUIPMENT

C-214

For more data circle 553 on Post Card

CONDENSER TUBE JOINTS

(Continued)

ing gland of the return end tube sheet.

Both Ends Expanded: — In exchangers with tubes expanded on both ends, the oyster knife can be used to collapse both ends and the tube pulled free. Another technique is to use the tube cutter or oyster knife on the return end, dismantle the return end tube sheet, machine the bell off the inlet end, and then drive the tube from the inlet end sheet. The tube ends in the return sheet are driven out after dismantling.

Still another method is to cut both tube ends, dismantle one sheet, pull the tubes free and then drive the tube ends from both tube sheets. If the exchanger is large enough to hold a man, as for example, a large steam condenser, the tube ends can be driven from the shell side face of the inlet sheet, in which case, the bell need not be machined off. If a man cannot conveniently work in the condenser shell, the tube ends must be driven into the shell side and the pieces cleaned out before retubing.

Tube removal and replacement is a highly developed art. Experienced men with specialized tools can do retubing work with surprising speed. Inexperienced personnel should never be permitted to do this type of work because of the danger of damaging the tube sheets or ruining a new set of tubes. Much thought should be given to the choice of tube joints, because selection of the proper one rewards the operator with maximum exchanger efficiency and minimum maintenance costs.

POWER PLANT LUBRICATION

(Continued from page 87)

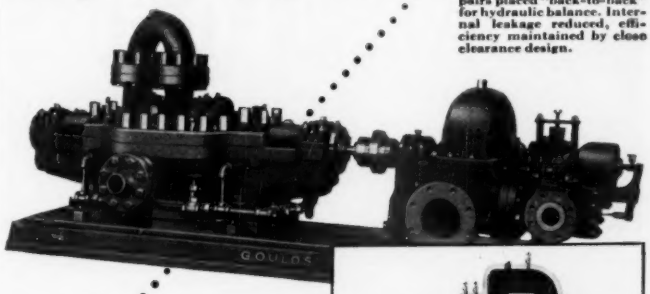
ically as an all new layout, for there may be hidden differences such as the difference between an ordinary bevel gear and a hypoid, or an increased tooth pressure to take advantage of newest techniques in the development of gear teeth.

Lubrication Schedules or Charts

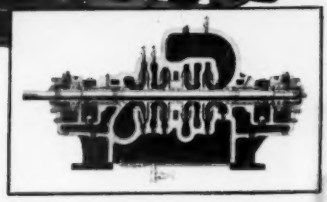
Each operating group of equipment, such as those items in a single department or room or the group policed by one man, should have a lubrication chart with columns somewhat as shown in Table I or approximately as follows:

1. *Operating Unit* (#1 service pump — #3 Blower — #6 Mill)
2. *Bearings* (crank case — steam or air cylinder — main shaft)
3. *Lubricant* (Make & designation)
4. *How applied* (Drip, Ring, Bottle — Hand — Gun — Spring cup, etc.)
5. *Frequency of:* (Check — Fill — Feed.)
6. *Drain, clean & refill* — (Monthly — Annual, etc.)
7. *Disposal* (Reclaiming Filter — Coal pile — sewer)

Keep Efficiency Up —

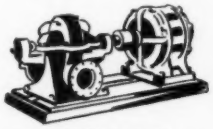


GOULDS Fig. 3360
Single-suction impellers in pairs placed "back-to-back" for hydraulic balance. Internal leakage reduced, efficiency maintained by close clearance design.



Costs down
with *Goulds*
High Pressure Centrifugal Pumps

Other GOULDS Pumps for Heavy-Duty Service



GOULDS Fig. 3450
These double-suction, single-stage Goulds centrifugals will handle up to 15,000 G.P.M. Heads up to 500 ft. Bulletin 721.2.

GOULDS Fig. 3705
Stainless steel pumps for handling acid and alkaline liquors. Capacities up to 600 G.P.M. Heads up to 160 ft.

GOULDS Fig. 3047
Nonclogging impeller of this vertical sump pump will handle water containing large solids or fibrous materials.

In power plant boiler feed service or other installations where high pressures and temperatures are encountered, it will pay you to specify Goulds High Pressure Centrifugal Pumps.

Low in cost and easy to install, they assure real economy. Goulds save you money while in operation, too. Their simple, durable construction provides years of 24-hour-a-day trouble-free service . . . means lower replacement costs and reduced maintenance for you.

The Goulds Fig. 3360, pictured above, is available in bronze fitted construction with heavy-duty, double ball bearings, in sizes 3″ to 8″, stages 2 to 8, capacities to 2250 G.P.M. Heads to 3050 ft. Bulletin 722.5 contains details and specifications. Write for it today.

MEMBER

Goulds PUMPS INC.
Seneca Falls
New York

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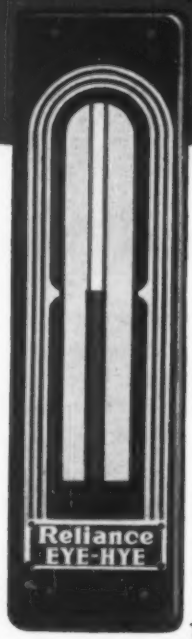
NOW-10,000 EYE-HYEs

have been sold—for safer, more accurate boiler water level supervision

The original remote reading gage

RELIANCE GAUGE COLUMN CO
CLEVELAND OHIO
EYE-HYE
MODEL NO E600A SERIAL NO 10,000
VERTICAL WATER LEVEL 16" INS. W.S.P. 440
USE ONLY VITZENE D IN THIS GAGE



- EYE-HYE assures perfect measurement, dependability and clear reading.
- All-hydrostatic principle—no mechanical parts —no adjustments on location.
- Reads in liquid, like a conventional gage, but easier, faster because of illuminated green indicating fluid.
- One model for all pressures to 600 psi. Heavier designs for pressures to 2000 psi. Also models for wide liquid level variation—for tanks, heaters, etc. *Write for Bulletin CO.*

The Reliance Gauge Column Co.
5902 CARNEGIE AVE., • CLEVELAND 3, OHIO

For more data circle 577 on Post Card

POWER PLANT LUBRICATION

(Continued)

Variations of such charts are many: One is a four column arrangement with these columns the same as above first four, using the remaining space for "Comments and Special Instructions."

This calls for writing out all application and disposal instructions for each item.

It is possible to make up such charts on standard size letter paper turned sidewise but double letter size works somewhat better as suggested in Note A, Table I.

In addition to the normal lubrication chart, a schedule of cleaning and draining is needed. This can be set up in many forms, one of which is shown as Table II.

In a subsequent article, the author will show how to provide effective storage and dispensing facilities for lubricant and how to keep accurate records.

EXCITATION SYSTEMS

(Continued from page 91)

can be applied to smaller machines, its use here is infrequent due to the greater simplicity and excellent performance of the direct-acting type. However, the indirect-acting regulator is capable of producing low or negative exciter voltages, and may be used in preference to the direct-acting regulator where such operation is essential. It is reliable and easy to maintain in spite of its greater complexity. Furthermore, by following a relatively simple procedure, it may be removed from service to place the machine under manual control without disturbing the machine load or terminal voltage. This regulator can usually maintain voltage within plus or minus one-half of one per cent of the desired value under steady state operating conditions over the full load range of the machine. Where small changes in excitation are required, its speed of response is adequate, and when larger changes are necessary, it will almost instantaneously provide maximum corrective action. This regulator is most satisfactory for applications where continuous and rapid machine load changes are not encountered.

Static regulators associated with rotary amplifiers may be applied to machines of any rating, but their use is generally confined to machines which are too large for the direct-acting electro-mechanical regulators, except where superior performance is required which will justify their greater size and complexity. Although they are not as familiar to operating personnel as the electro-mechanical types, and are therefore not as well understood, the basic circuits of static regulators are not complicated. Except for attention to the rotary amplifier of

(Continued on page 136)

What's the $ Connection?

If there's a furnace operation in your setup . . . there's a mighty big connection between the CITIES SERVICE HEAT PROVER and your profit and loss picture.

Heat Prover—not an instrument you buy, but a service we supply—helps to increase furnace productivity through these five unique advantages:

1. **Rapid, continuous sampling.**
2. **Simultaneous reading of oxygen and combustibles.**
3. **Direct measurement of oxygen and combustibles.**
4. **Easy portability.**
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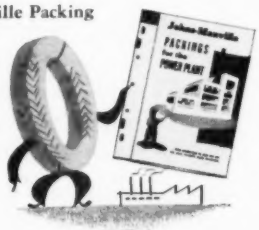

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HELPFUL BULLETINS

(*Continued from page 88*)

to 350 hp are featured in Bulletin L-676-B1, 32 pp. Includes illustrated discussion of the Feather Valve, also frame, running gear parts, cylinder, intercooler, variable capacity control. Worthington Corp.

CONDENSERS

130 Surface Condensers — Booklet B-4350, 32 pp, on radial-flow surface condensers, tells what radial-flow design is and lists its features. Color diagrams show heat transfer, surface activity and deaeration of condensate; shop photos show shell construction, how tube supports and plates are installed etc. Cutaway diagrams explain air baffle construction for various water-box arrangements and a cutaway view with colored overlay shows steam and air flow in a two-pass condenser. Westinghouse Electric Corp.

131 Compressors, Condenser Units — Eight-pp Bulletin DB 101-160 describes hermetically-sealed refrigeration compressors and condensing units of 75 to 100 hp capacity. Generously illustrated, gives inside story on company's CL8 compressors and condensing units and their component parts; also lists accessories for condensing units. Sturtevant Div., Westinghouse Electric Corp.

MECHANICAL POWER TRANSMISSION

133 Roller Bearings — Catalog 522, 16 pp, contains specifications of bearing selection for materials handling and other applications. Describes rollers, bearings, roller assemblies, cage and split outer race assemblies together with selection data covering load speed factor, stationary shaft factor and bearing life with shaft, housing limits. Berlin Bearing Co.

134 Ball and Roller Bearings — Sixteen-pp Catalog 28 is a well-organized ordering guide covering a line of ball thrust bearings, roller thrust bearings, step bearings, journal roller bearings, industrial roller bearings and special bearings. All types are illustrated by photo and dimensional drawings and standard sizes listed in tabular form. The Gwilliam Co.

PACKINGS

136 O-Ring Slide Rule — Now available to power engineers who must determine proper size O rings for various applications is a slide rule data chart covering manufacturer's Series 6227 and Series 6230 O rings. Pocket-sized, and in slide rule form it shows the size to use. Plastic and Rubber Products Co.

137 Data on Packings — Now available to power engineers is an informative data file on manufacturer's Tannate leather packings, their design and application. Includes a folder offering service hints as well as installation and maintenance procedures for U, V, cup and flange packings for hydraulic and pneumatic equipment. Complete specifications for Tannate packings included. J. E. Rhoads & Sons.

LUBRICANTS, OIL-HANDLING EQUIPMENT

139 Anti-Seize Lubricant — This illustrated bulletin describes advantages of company's molybdenum disulfide lubricant in a wide range of uses wherever extreme pressures are encountered. This product is said to prevent seizing and galling at bearing pressures over 100,000 psi. Bel-Ray Co., Inc.

140 For Automatic Lubrication — Sixteen-pp Catalog L-52 describes force feed lubricators for all types of machinery. Illustrated, gives full design and construction details on company's open and enclosed type lubricators, available in capacities from 2 to 32 pints with 1 to 24 feeds per unit. Hills-McCanna Co.

141 To Prevent Oil Failure — "Proven Protection Against Oil Failure" is an 8-pp bulletin offering a solution to power interruptions, breakdowns and other problems resulting from contaminated oil in diesels, turbines, transformers, circuit breakers, switchgear and other oil-filled equipment. Discusses two-way protection provided by company's oil purifiers. Hoosa-Cramer Corp.

TUBING AND HOSE

142 Versatile Flexible Tubing — A line of flexible tubing in diameters from less than 1 in. to 30 in. is described in 4-pp Catalog C2-3. This ducting, made of fabric supported rubber or plastic wound on helical spring wire coils, is lightweight, retractable, non-collapsible and flexible enough for 180-deg turns. Its use in ventilation service, fume removal, dust collection and materials handling, as well as in maintenance listed. Flexible Tubing Corp.

143 Hose and Tubing — Catalog CC-400 is a 16-pp illustrated quick-reference booklet on manufacturer's flexible metal hose and tubing. These products are made in two basic types: seamless and strip wound. Catalog shows wide range of available alloys and sizes, suggested applications; also furnishes engineering data. The American Brass Co.

OTHER EQUIPMENT

144 Industrial Turbine-Generators — Twenty-pp Bulletin B-5418 illustrates some 30 applications of industrial turbine generators. Because requirements vary from applications where maximum conversion of heat energy to electrical power is most important to those in which process steam is of primary concern, booklet describes the six principal types of industrial turbines: non-condensing, non-condensing single-extraction, non-condensing double-extraction, condensing single-extraction, condensing double-extraction and condensing turbines. Westinghouse Electric Corp.

146 Industrial Waste Treatment Guide — Eight-pp Bulletin 4 contains a highly useful table showing different types or combinations of unit treatment processes for more than 50 wastes. Another table shows equipment used in the several unit treatment processes; a third table shows company's equipment available. Includes installation photos and large flow diagram. B-I-F Industries Inc.

147 Complete Boiler Water Conditioning — Stressing need for thoroughness in treating water for use in boilers, this 12-pp brochure discusses three aspects of a complete program: survey, treatment and control and explains the benefits. Power Chemicals Div., E. F. Drew & Co., Inc.

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Catalog Library

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WATER CONDITIONING

201 **Chlorination for Power Plants** — Form RA-2061-C is a 20-pp technical article, "Recent Developments in Chlorination and Equipment for Power Plants." Discusses such subjects as industrial water chlorination, the desliming processes, air pilot chlorinator operation, organic slimes and scales, chlorine ammonia reactions, chlorine residual recording. Wallace & Tiernan Products, Inc.

202 **Water Treatment** — Bulletin 5000, 24 pp, explains the reasons for boiler water treatment and tells services offered by company in providing formulations for individual plant requirements. Covers pre-treatment, internal treatment, treatment application, blowdown adjustment, test control. Describes equipment. Dearborn Chemical Co.

203 **Carryover Prevention** — Eight-pp Technical Paper 115 discusses the role of anti-foam agents in the prevention of carryover of boiler water solids with steam. Covers mechanical and chemical influences on carryover, foaming and anti-foam action, types of anti-foam agents. W. H. & L. D. Betz.

204 **Water Conditioning Data Book** — Recently revised, this pocket-size 116-pp booklet presents a compilation of 77 tables, all valuable to the power engineer. Covers such subjects as hydraulics, impurities in water, boiler feedwater make-up requirements, chemical conversions and chemical reactions. Contains excellent reference information on many phases and methods of water treatment. Available without charge to qualified power engineers. The Permutit Co.

205 **What's New on Ion Exchangers** — Here are three booklets on ion exchangers: Nalcite HCR, a styrene type cation exchanger; Nalcite SAR, a strongly basic anion exchanger; and Super Nalcolite, a synthetic gel type zeolite for cation exchange. Tables and graphs explain performance of these water treating resins under various operating conditions. Physical characteristics, exchange capacities, regeneration techniques discussed. Bulletin 57, 20 pp, is on Nalcite SAR; Bulletin 58, 28 pp, Nalcite HCR; Bulletin 59, 8 pp, Super Nalcolite. State those wanted. National Aluminate Corp.

206 **Modern pH and Chlorine Control** — This 100-pp booklet gives details on color comparators and equipment in water testing and control of boiler and industrial process water, also technical information on meaning of pH control, electrometric and colorimetric methods of determining pH and impurities in water; applications of water control in air conditioning; treating boiler feed water. W. A. Taylor & Co.

207 **Treatment by Ion Exchange** — Methods of ion exchange treatment and its general and special applications for water and other liquids are explained in 8-pp Bulletin A. Discusses manufacturer's de-ionizing equipment as to construction and operation and pictures some typical applications. Illinois Water Treatment Co.

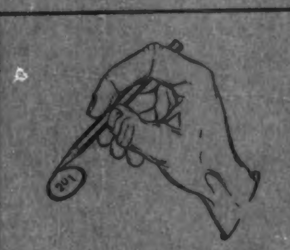
208 **Steam System Treatment** — This bulletin on Coravol for prevention of corrosion, explains theory of corrosion, application of organic amines to steam systems (the Coravol process) and presents case histories of use in different types of plants and industries. Coravol is part of a complete technical service providing special chemical formulas for treatment of water, steam, brine, fuel. Western Chemical Co.

209 **New Data on Zeolite Softeners** — Publication 4520-A is a recently revised edition of company's booklet on zeolite water softening. Provides a glossary of terms used in the process, data for laying out a zeolite softening plant, factors governing size of equipment, selection of zeolite materials and discussion of the four stages of operation of a sodium zeolite softener. Cochrane Corp.

210 **Water Conditioning Bulletin** — This is an 8-pp discussion of water and the chemicals developed for conditioning it to control scale and algae and inhibit corrosion. Describes several chemicals in detail, giving properties, composition. Wright Chemical Corp.

211 **Feedwater Treatment** — Here is a 10-pp illustrated report on boiler feedwater treatment for a high-pressure, high-makeup power and steam producing plant. It is based on studies to determine best method of meeting requirements for both the high-pressure steam used in power generating turbines and the district heating steam for downtown Philadelphia. Reasons for deciding on a demineralizing plant are given. Graver Water Conditioning Co.

212 **Water Conditioning Information** — Here are three informational bulletins. No. 28X7446 describes a



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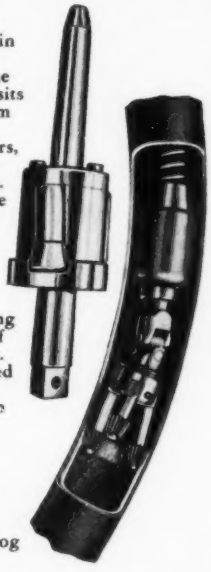

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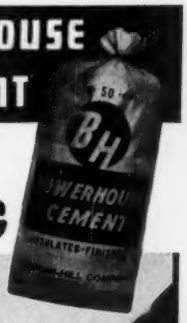

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simple way to determine total hardness in water, illustrating procedure. No. 28X7559 gives an analysis of the hot process-hot zeolite system telling results to be expected. No. 28X4766 discusses current status of embrittlement in boilers, explaining causes and control methods. List bulletins wanted. Allis-Chalmers Mfg. Co.

213 Corrosion Treatment — "Corrosion Protection of Steam and Condensate Return Systems" is a folder on amine treatment for boiler and condensate systems. This treatment is described as affording surface protection of the metal as well as raising pH value of condensate. The Bird-Archer Co.

214 One-Minute Water Tests — Rapid, simple and accurate tests for determining water hardness are described in Bulletin 1RE50. Procedures, reagents, and equipment are described. Hall Laboratories, Inc.

215 Boiler Water Manual — Factual information on methods of applying chemicals in treatment of water for boilers is presented in 16-pp Standard Method 122. Discusses pretreatment of raw water, application of chemical feeding to pretreating operations and both constant rate and flow responsive feeding direct to boiler drum and to feed-water system, condensate returns, % Proportioneers, Inc. %

216 Feedwater Treating — Bulletin 1855, 30 pp, features manufacturer's hot process Accelerator for treatment of boiler feedwater, illustrating and explaining its operation and advantages, also optional equipment. Contains excellent discussion of necessity for treatment of makeup water, selection of proper equipment. Also covers limitations of hot process softening. Infilco Inc.

BOILERS, GENERATORS

217 Shop-Assembled Boiler — Sixteen-pp Bulletin G-76, completely describes and illustrates company's Type FM water-tube integral-furnace boiler, made in standard sizes from 2000 to 28,000 lb of steam per hr, pressure to 250 psi. Savings in erection, installation and moving costs are stressed along with wide range of applications. Capacities, dimensions and weights are given along with efficiency data. The Babcock & Wilcox Co.

218 Re-Circulation Steam Generator — Here's a 6-pp folder on a controlled re-circulation steam generator, describing its development and uses, such as applications where steam is required in remote locations, where demands are intermittent, or load fluctuating. Combustion Engineering-Superheater, Inc.

219 Steam Generators — Twenty-pp Bulletin SB43, 20 pp, describes company's VL factory assembled generators combining 2-drum water-tube boiler, integral water cooled furnace, brick work, insulation and steel casing. A large cutaway illustration shows design details, and gas travel. Use of generator with various fuels and firing arrangements is covered. Erie City Iron Works.

220 Steam Boilers — Form SG 128–749 is a 12 pp catalog illustrated with photos of steam boilers for processing and heating, ranging from 15 to 500 hp and 15 to 200 psi. Includes diagrammatic cross-section of four-pass design characteristic of manufacturer's boilers. Cleaver-Brooks Co.

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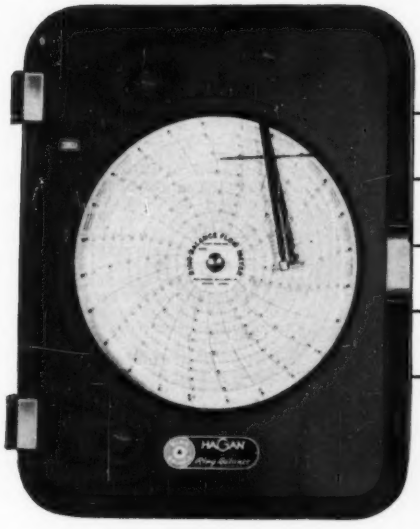

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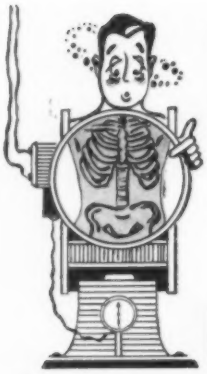

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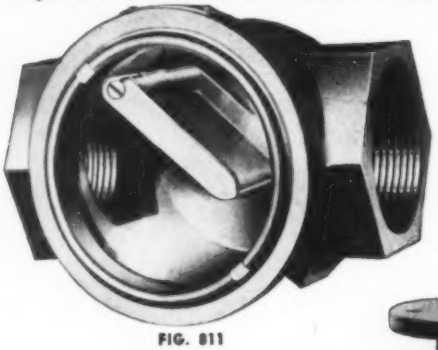

FIG. 811

FIG. 811

This vane-type Bowser Indicator is spring-actuated, thus providing an indication of the quantity flowing in the line.

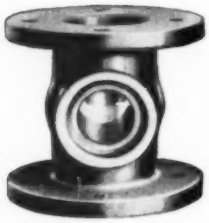

FIG. 54A

FIG. 54A

This Bowser Flow Sight is recommended for use on gravity lines where the flow is vertically downward.

FIG. 816

FIG. 816

The Figure 816 Bowser Teleflo Indicator is equipped to operate a gong or to stop pump motor if liquid flow stops.

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FUEL OILS, LUBRICANTS

221 Cooperative Technical Consultation Service — This informative 24-pp booklet presents company's periodic consultation service aimed at the most efficient use of petroleum products. Covers services available in the solution of lubrication problems, metalworking operations, processing, fuel oils, dust control. Gulf Oil Corp., Gulf Refining Co.

222 Air Compressor Lubrication Manual — Valuable information on air compressor maintenance is contained in this 40-pp book. Subjects treated include compressed air, compressors and related equipment, lubricating systems, compressor oils and applications, lubrication requirements, operating hints, oil requirements, storage and care of compressor oils, safety precautions. Cities Service Oil Co.

223 Lubrication of Diesel Engines — An excellent instruction manual, 50-pp Technical Bulletin B-1 (revised) also provides a brief history on diesel engines, an explanation of the fundamentals of design and the common types of diesels and their advantages. Explains combustion process, discusses modern fuel injection systems. Cylinder and bearing lubrication are treated and recommendations given for lubricating oils. Sun Oil Co.

224 Diesels, Their Fuels and Lubricants — This 46-pp book gives practical information on diesel engines, covering their history and economics as well as design characteristics and operating principles. Classification of diesels according to their speed is also explained. Sinclair Refining Co.

225 Clean Oil for Diesels — A combination purifying and filtering unit utilizing centrifugal force and controlled filtration is the subject of illustrated Bulletin DL-1. Explains operation of the unit, tells advantages. Discusses importance of clean, dry lubricants. The De-Laval Separator Co.

226 Versatile Industrial Oil — Described in 20-pp Form AD 4078 is an all-purpose oil offering protection for a wide range of industrial equipment, and available in 15 viscosity grades. Discusses six major characteristics of the oil; explains and pictures its use in hydraulic systems, speed reducers, air compressors, electric motors, hydraulic turbines, bearing systems, etc. A chart shows grades available, their uses and physical properties. Standard Oil Co. (Ind.)

227 Viscosity of Fluids — The larger significance of viscosity is discussed in Nos. 5 and 6, Vol. 36 of Lubrication, a technical publication. In six parts, the first illustrates simplest conception of streamline flow between two surfaces having relative motion. Part II covers streamline flow in capillary and other small tubes. Part III covers turbulent flow in pipes. Part IV discusses effects of temperature and pressure on viscosity, and Part V includes viscosity index. Part VI provides a brief reference to the nature of plastic flow. The Texas Co.

228 Turbine Oil Conditioning — Bulletin 832-P, 12 pp, offers a detailed explanation of the reasons for turbine oil conditioning, the way in which company's dry type conditioning equipment nullifies or prevents factors which promote deterioration of oil, Bowser, Inc.

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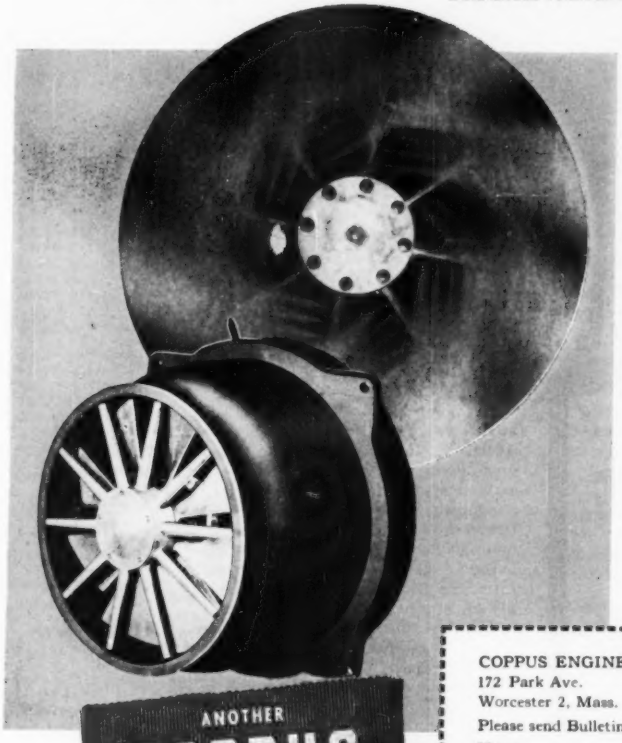

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FANMIX can easily be operated with your present furnace and stack, requiring only minor changes in other equipment. Or if you're planning on new boilers, remember that FANMIX relieves the furnace from the burden of mixing, creates its own forced draft and takes smaller pipe sizes. Which means you can plan on reduced combustion space, less stack, no forced draft equipment and lower installation costs all around.

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Coppus engineers FANMIX Burners to meet individual requirements, providing complete control over heat pattern and combustion . . . Learn more about how "pinwheel action" can step up *your* boiler performance to peak efficiency and economy — as it is doing throughout industry. Send for Bulletin 410-6. Coppus Engineering Corp., Worcester 2, Mass. Sales Offices in THOMAS' REGISTER. Other Coppus "Blue Ribbon" Products in BEST'S SAFETY DIRECTORY, CHEMICAL ENGINEERING CATALOG, REFINERY CATALOG, and MINING CATALOGS.

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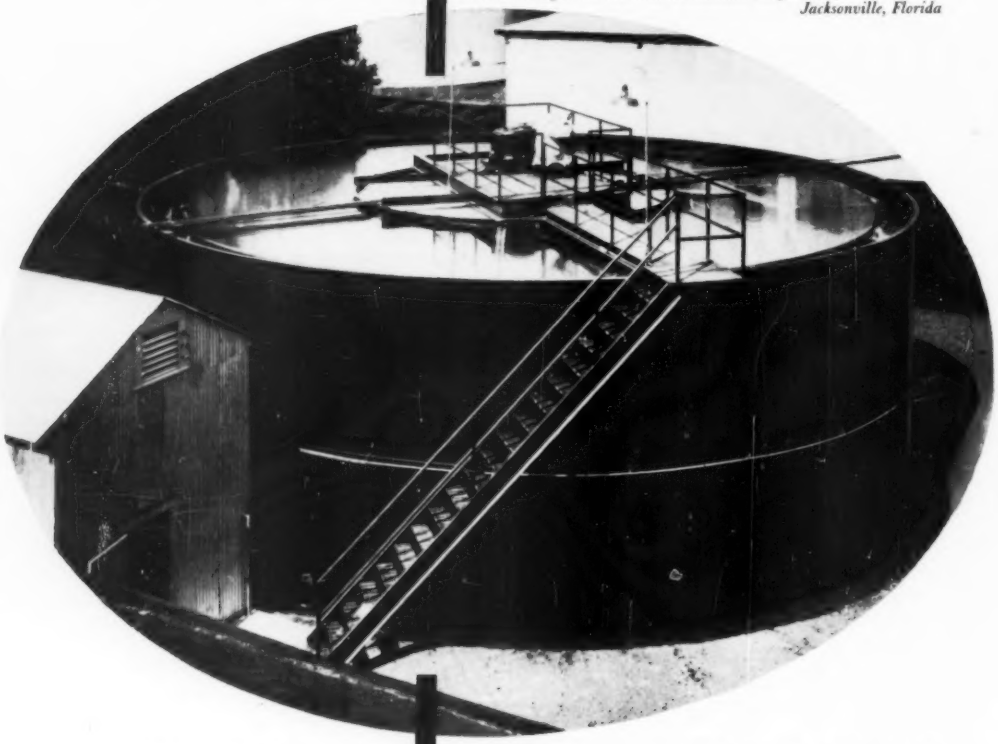
Reduces Chemical Consumption 32%

Selectively removes calcium bicarbonate to eliminate scaling—shutdown—cleaning losses using minimum chemical dosages

Accelator Softener at National Container Corporation, Jacksonville, Florida



PROBLEM—Calcium Bicarbonate caused troublesome scale at this Florida plant. Costs for acid cleaning ran to excess and it became imperative to prevent loss of production.

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SOLUTION—The controlled slurry recirculation in the Accelator eliminates localized overtreatment, and makes possible the selective precipitation of almost pure calcium carbonate with virtually no magnesia contamination. Lime is required only for reaction with calcium bicarbonate and free carbon dioxide—resulting in chemical savings and a more stable effluent. The virtually clear effluent obtained in the Accelator, with its chemical stability, minimizes scale formation and results in further savings in chemicals for pH adjustment.

The Accelator offers important space-saving advantages as well as improved results in treatment of water, sewage or a wide variety of trade wastes.

Get savings in first costs as well as efficient plant performance with INFILCO'S Accelator.

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FUEL BURNERS

229 Gas Burners — Illustrated Bulletin 410-8, 16 pp, furnishes descriptive and technical data on company's gas burners and combination gas and oil burners, giving design details and explaining operation of each type. Coppus Engineering Corp.

230 Steam Atomizing Oil Burners — Sixteen-pp illustrated Bulletin 21 describes steam atomizing oil burners and auxiliary equipment for use with heavy oil or tar in boilers, stills, dryers and other furnaces, where steam or compressed air is available for atomizing the oil. Discusses steam and oil control valves. National Airoil Burner Co., Inc.

231 Oil Burning Equipment — Bulletin O-B 37 contains 16 pp of technical information on company's oil and gas burning equipment, steam atomizing burners, mechanical atomizing burners, interchangeable burners, telling best applications, including capacity data. Also shows fuel oil pumping, heating systems. The Engineer Co.

PUMPS AND COMPRESSORS

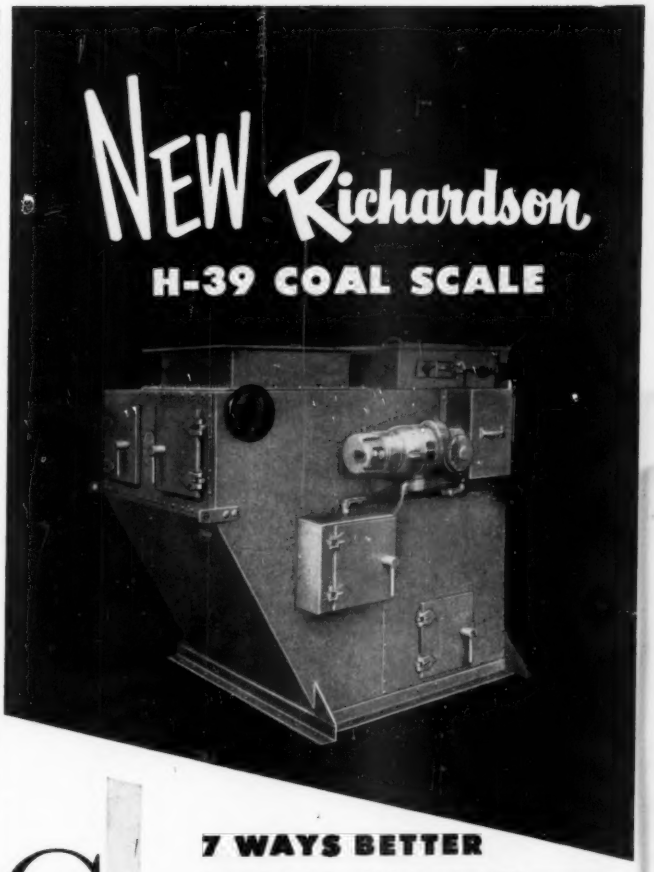
232 Centrifugal Pump Handbooks — Two instruction booklets covering the installation, operation and repair of company's single-stage single-suction and multi-stage centrifugal pumps are available. Suggest regular inspection procedures and include pages for maintenance records. Also provide handy tables explaining how to locate trouble and listing causes and cures. Bulletin 08X7813, 24 pp, covers single-stage pumps; Bulletin 08X7780, 48 pp, covers the multi-stage pumps. State choice or both. Allis-Chalmers Mfg. Co.

233 Boiler Feed Pumps — Bulletin 109, 16 pp, illustrated in color, describes centrifugal pumps for boiler feed service. Pictures construction and major parts, floating seal incorporated. Capacity data, vapor pressure tables included. Pacific Pumps, Inc.

234 Centrifugal Sump Pumps — Eight-pp Bulletin WQ-220 announces improved models of company's Types VS and VN sump pumps, available in wet and dry pit types and adapted to handling clear liquids, sewage and other liquids containing solids, in capacities to 1000 gpm and pressures to 250 psi. Explains advantages of these vertical centrifugal pumps. Includes specifications. Warren Steam Pump Co., Inc.

235 Condensed Pump Data — Form 4383-J covers more than 20 types of general service pumps, rotary pumps, sump and drainage pumps, condensate units, self-priming units, stainless steel pumps and high pressure pumps. In easy-to-find tabular form, each model is pictured along with its characteristics, applications, features and references to specific literature providing further information. Lists selection factors. Goulds Pumps, Inc.

236 Controlled Volume Pumps — Bulletin 351, 16 pp, describes company's air-powered controlled volume pumps, designed to pump practically any liquid in measured volumes accurate to within a fraction of 1 per cent. Pumps are reciprocating, positive displacement plunger types. Cross-sectionals show design and operating details. Controls and typical automatic feed systems are discussed. Milton Roy Co.



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C439 ROTOJET Junior Air-driven Motor, universal joint, drill head

C324 ROTOJET Junior Water-driven Motor, univ. joint, pivot head.

C434 ROTOJET Junior Air-driven Motor, flexible coupling, expanding brush.

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237 Boiler Feed Pump — A barrel-type boiler feed pump for high pressure, high temperature service and designed to go on the line quickly without preliminary warm-up, is the subject of 12-pp Bulletin 1525. Fully illustrated text explains automatic operation of hydraulic thrust balance incorporated in this pump. De Laval Steam Turbine Co.

238 Compressor Selection Chart — Based on normal applications handling air with atmospheric intake pressure, this chart simplifies selection of proper size compressor, giving quick comparison between discharge pressure pounds per square inch gage and piston displacement cubic feet per minute. Worthington Corp.

PACKINGS, GASKETS, SEALS

239 Manual on Packings — Containing 84 pp of engineering and ordering information, Catalog 40 covers packings for practically every service. Includes packaging recommendation charts, conversion tables. The Belmont Packing & Rubber Co.

240 Packings and Gaskets — Catalog P-100C, 32 pp, covers 95 most popular packings and gaskets in company's line, furnishing details of construction, service recommendations and size information. Includes charts showing specific recommendations for a wide variety of applications. Packing Div., Raybestos-Manhattan, Inc.

241 Packings for the Power Plant — Designed as a quick-reference aid, one feature of this compact 6-pp guide is a flow sheet of a rudimentary industrial power plant with each unit keyed to the proper packings and gaskets. These, in turn, are illustrated with photos and construction information, sizes, etc. Packings and gaskets are grouped according to recommended applications and services. Johns-Manville.

242 Seals for Bearings — Complete information on manufacturer's Klozure oil and grease seals for bearings is available in 100-pp Catalog 10. Fully illustrated in color, pictures all types of these seals, typical applications and lists sizes and part numbers. Also describes mechanical pressure seals for rotary shafts. The Garlock Packing Co.

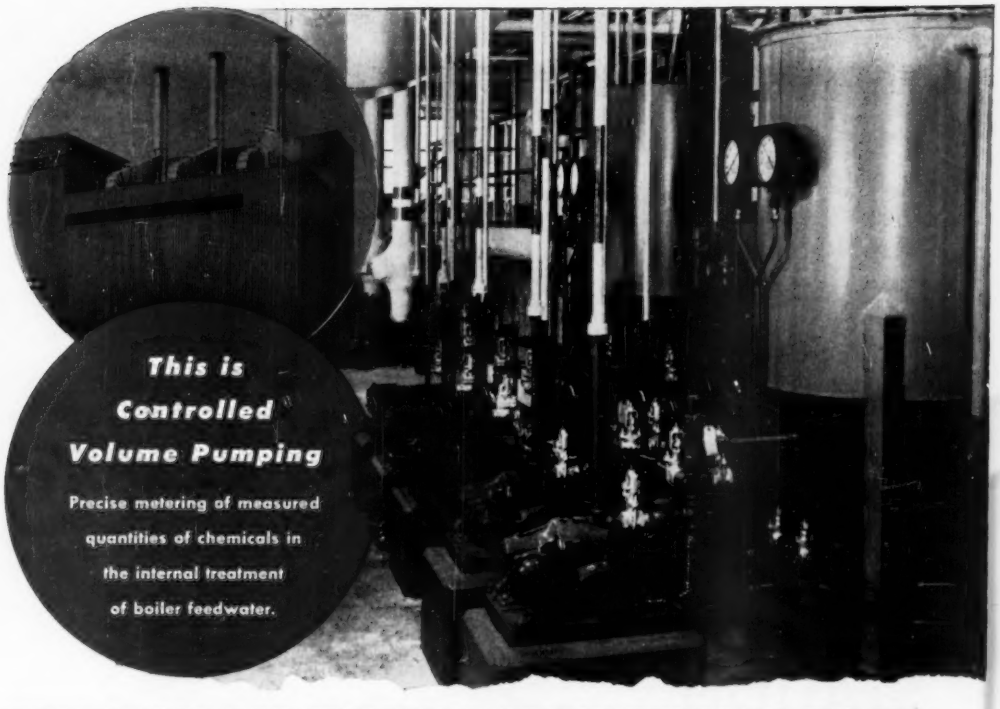
VALVES, TRAPS, PIPING AND ACCESSORIES

243 Check Valves — Twenty-pp Catalog 30 presents company's line of tilting-disc check valves made in iron, bronze and steel for working pressures to 3000 psi. Explains operating principle of tilting disc construction, discusses closing without slam, reduced loss of head, other advantages. Includes construction details, sizes. The Chapman Valve Mfg. Co.

244 Gate Valves — Literature is available on cast steel outside-stem-and-yoke gate valves; also on bronze, iron, steel and corrosion-resisting valves in a variety of types. The Wm. Powell Co.

245 To Get at Those Valves — This little folder describes a sprocket rim with chain guide. The rim adjusts to fit all sizes of valve wheels. Babbitt Steam Specialty Co.

246 Blow-off Valves — Illustrated Bulletin B-433, 24 pp, describes blow-off valves for high-pressure boilers,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Precise metering of measured quantities of chemicals in the internal treatment of boiler feedwater.

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The modern Beloit, Wisconsin steam generating plant of Fairbanks, Morse & Co., manufacturers of diesel engines, locomotives, generators, pumps, motors and magnetos, is designed to handle heavy processing loads and plant heating. To help maintain the continuity of service so vital to power plant operation, company engineers placed emphasis on methods of preventing corrosion and other destructive conditions in the boiler feedwater system. Five Milton Roy Controlled Volume Simplex Pumps are employed to meter precise quantities of chemicals into the boiler feedwater: disodium phosphate for residual water hardness in the boiler drums; sodium sulphite for oxygen removal in the deaerator and feed lines; organics for prevention of precipitation in economizer and feed line; alkalene polyamide as anti-foam for reduction of surface tension; octadecylamine for steam and return line corrosion. Fairbanks, Morse & Co. specified Milton Roy Controlled Volume Pumps because of their metering accuracy, service dependability, positive and flexible control, low maintenance.

Boiler feedwater treatment is only one of many applications of Milton Roy Controlled Volume Pumps. They're also used in all forms of internal and external feed systems, including introduction of chemicals directly to boiler drums, intermittent feeding followed by condensate flushing, automatic chemical injection in ratio to flow, automatic pH control, and automatic control by conductivity.

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For additional information on Milton Roy Controlled Volume Pumps and Automatic Chemical Feed Systems, call the Milton Roy field representatives listed in your classified telephone directory. Or get in touch with us.

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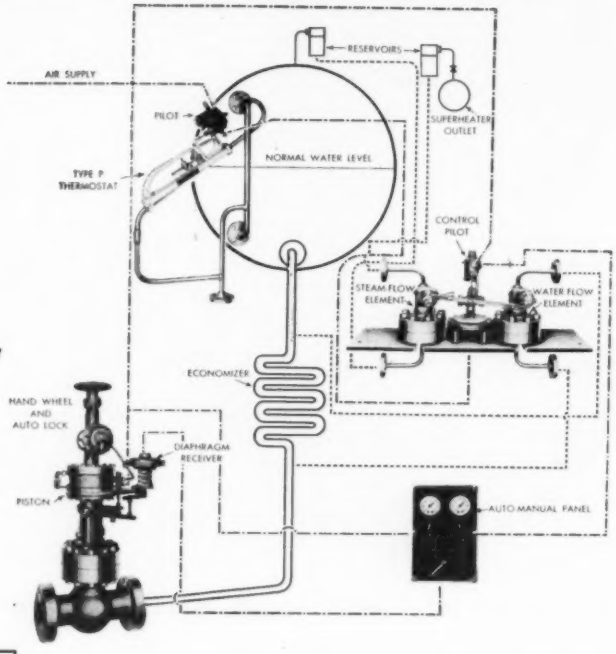

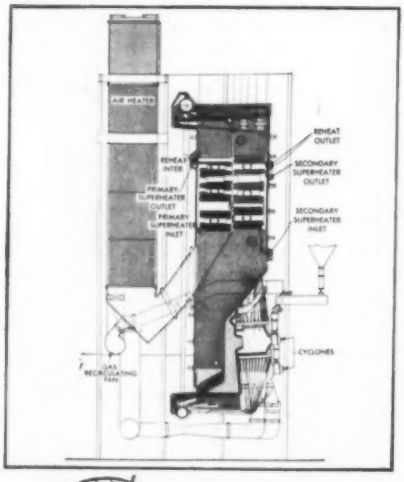

Three-influence COPES Balanced Flow Control will handle boiler feed on two 885,000-pounds-per-hour boilers at Niles Station. This modern regulator combines influences of steam flow, water flow and water level to assure stable drum level and feed in accordance with load demands.

Subject to few outages—even for routine maintenance—and easily adjusted for changed conditions while in operation, the COPES Balanced Flow is recommended for those high-duty steam generators which demand high regulator availability. The facts are yours on request.

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and covers seatless, hard-seat and unit-tandem types, for working steam pressures from 400 to 2500 lb. Construction details and operating principles illustrated. Dimensions and specifications included. Yarnall-Waring Co.

247 General Service Valves — Bulletin E-160, 16 pp, describes and illustrates design and construction of company's quick-operating valves, explaining their application to blow-off service and on chemical process, soot blowers, water column blow-down, and other types of pipe line. Everlasting Valve Co.

248 Pressure Reducing Valves — Selection and engineering data on pressure reducing valves, including those for remote control of reduced steam or water pressures, are in 12-pp Bulletin 477-A. Northern Equipment Co.

249 Safety Valve Engineering Data — How company's safety valve works and its operating advantages are explained in Bulletin 707. Includes dimensions on valve types, tables on superheat correction factor. Manning, Maxwell & Moore, Inc.

250 High Pressure Gate Valve — Described in 4-pp Form DH-273 is a forged steel gate valve designed for long service and low cost maintenance. Working pressures, sizes and prices listed. R-P & C Valve Div., American Chain & Cable Co., Inc.

251 Popular Steel Valves — Condensed Catalog 104, 28 pp, describes and illustrates most widely used of company's cast and forged steel valves and the data presented for these valves is complete. Those listed are chiefly in the basic steam pressure classes — 150 to 2500 lb — and include globe and angle, gage, instrument, hydraulic and relief types, also strainers and check, gate, non-return and blow-off valves. Edward Valves, Inc.

252 Steam Trap Book — Catalog J is the 44-pp new edition of this company's popular trap book and serves as a manual of trapping practice. Includes a catalog section giving physical data and prices on cast semi-steel and forged steel inverted bucket steam traps, compound steam traps and ball float air and air relief traps; a handbook section explaining how to calculate condensate loads and select traps for all classes of equipment; a maintenance section explaining trap installation, trouble-shooting and repair. Armstrong Machine Works.

253 Steam Trap Reference Manual — Bulletin T-1740, 24 pp, tells why and where steam traps should be used; explains desirable trap features. Advantages of company's impulse steam traps are described, their operation illustrated. How to figure trap sizes and how to size condensate return lines are told and capacity and pipe dimension charts and thermodynamic properties of saturated steam included. Also provided are installation and operating suggestions, prices. Yarnall-Waring Co.

254 Steam, Air and Gasoline Traps — Illustrated Catalog 751, 32 pp, provides capacity tables, installation diagrams and a section containing data, charts and formulas for determining proper size trap for specific applications. Covers thermostastic steam traps for pressures to 225 lb, expansion steam traps, weight-operated traps for steam, air and gasoline as well as

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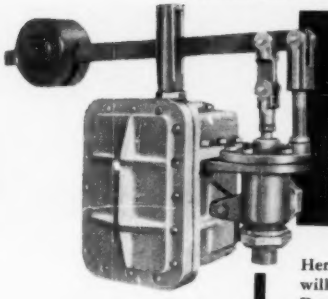

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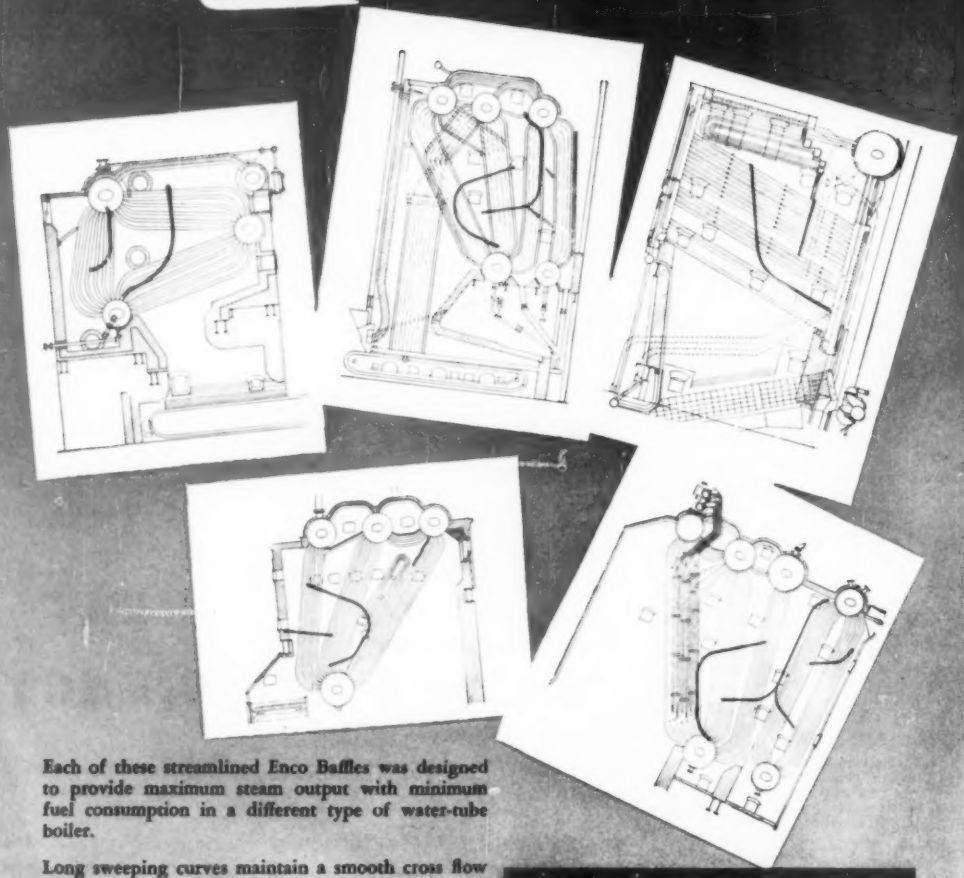

Each of these streamlined Enco Baffles was designed to provide maximum steam output with minimum fuel consumption in a different type of water-tube boiler.

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Enco Streamline Baffles are individually designed and engineered to the exact requirements of your boiler. Experienced Enco-trained crews take charge of the installation.

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piston-operated steam traps. W. H. Nicholson & Co.

255 Solving Steam Trap Problems — This popular 36-pp catalog on steam traps contains specifications and capacities on steam traps, float traps, air release valves and pipe line strainers. Tells how to calculate condensation loads and select traps for all classes of equipment, including unit heaters, jacketed kettles, autoclaves, submerged surfaces, steam mains and header drips. Gives pointers on how to install and service traps. The V. D. Anderson Co.

256 Piping Pointers — This is company's highly popular 36-pp manual covering fundamentals of sound piping practices. Discusses various types of valve designs and how each should be used. Pictures and names more than 80 fittings and contains illustrated how-to-do-it features. Includes 8 pp valve selection guide. Crane Co.

257 Duplex Strainer — This literature describes company's Duplex strainer with single handwheel control. Shows how it is designed with only one stuffing box and can be cleaned under full flow. R. S. Products Corp.

258 Valves, Fittings and Flanges — Catalog F-9 is a 400-pp, permanently bound reference book on drop forged steel valves, fittings and flanges for practically all piping needs at high and low pressures and temperatures. Provides ordering information on company's complete line, also much helpful engineering and application data: includes a section on products for refrigeration service. Available to qualified power engineers; please give your title. Henry Vogt Machine Co.

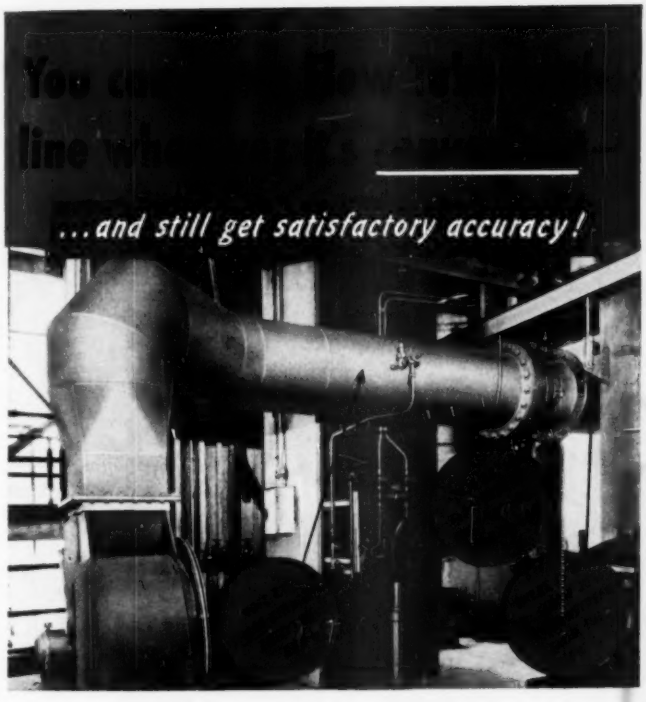
259 Design Properties of Pipe — This 12-pp booklet consists of tables listing pipe sizes and wall thicknesses currently established as standard, plus dimensional properties of commercially available sizes of steel pipe. Tube Turns, Inc.

260 Handbook on Fittings, Flanges — Catalog wf-1950, 68 pp offers working information on seamless carbon steel welding fittings and forged steel flanges. Includes dimensional tolerances, thread standards and threading practice; service pressure ratings, physical and chemical requirements. Grinnell Co., Inc.

TUBING

261 Double-Walled Tubing — Technical Bulletin 1950, 12 pp, presents tubing designed for conditions where single-walled tube can't withstand simultaneous attack from two types of corrosive media. Describes and illustrates construction, illustrating possible metal combinations. Explains tubing's use in ammonia refrigeration, boilers, steam generators. Discusses heat transfer properties, high temperature use. Bridgeport Brass Co.

262 Condenser Tubes — Excellent factual information on condenser tubes and their service life is given in this 40-pp illustrated booklet. Subjects discussed include corrosion of condenser and heat exchanger tubes, corrosion resistance and control, the selection of tube materials, and the composition and physical properties of company's alloys. Details on proper tube installation are presented, as are specifications, conversion tables, weights of tubes and alloys, formulas, terminology. Scovill Mfg. Co.



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All are performing satisfactorily as installed. Periodic checks all show that they are measuring within plus or minus 2% of the blower manufacturer's characteristic curve.

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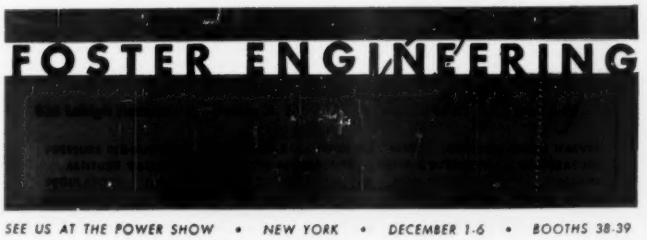

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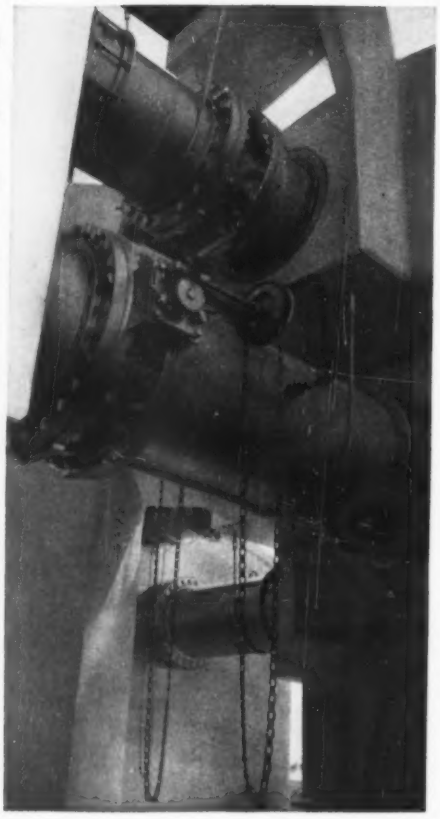

Few Chainwheel Turns. R-S Valves are completely closed from the fully open position by the movement of the valve vane through 77½° of arc. Operating ease is one of the chief advantages of R-S Valves.

Economy in First Cost. R-S narrow face-to-face design results in minimum number of working parts, less metal, less machining, lower weight and less supporting structure—hence economy in first cost.

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Consult your local R-S Valve Engineers, or write direct.

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263 Life Extension for Condenser Tubes — This 32-pp extensively illustrated booklet reports on research into the causes of corrosion and means of combating them, as well as the choice of condenser tube materials. Points out that Admiralty metal, long a standard for power plant condenser tubes, works satisfactorily in most installations, but other alloys may be necessary in some circumstances. Revere Copper and Brass, Inc.

264 Nickel Pipe and Tubes — Bulletin T-17 is a 27-pp technical bulletin on the fabrication and design of nickel and high nickel alloy pipe and tubing, illustrated throughout by drawings and photos. Presents tables on mechanical and physical properties, ASME code requirements, recommended welding procedures. The International Nickel Co., Inc.

COAL, ASH HANDLING

265 Spreader Stoker Data — This is a file of three illustrated bulletins on spreader stokers. The first discusses seven reasons for selecting these stokers and describes their design, construction and operation; the second, dumping grates, the third, installations. Riley Stoker Corp.

266 Where Refuse Is Fuel — Presented in 24-pp Bulletin are installations of company's stokers with medium-size and larger units burning refuse fuels, separately or in combination with coal. Lists many of the refuse fuels handled successfully by this type of spreader stoker. Detroit Stoker Co.

267 Coal Scale — Bulletin 0250, 12 pp, describes a pressure-tight, automatic coal scale, its construction and operation. Shows how beam system, electrical components and linkages are protected from exposure to coal dust. Richardson Scale Co.

268 Economic Coal Storage — How tractors establish safe, orderly coal handling is told in this 8-pp booklet. Stresses flexibility, low operating costs. Also shows how tractors speed storage reclamation and how a tractor-scraper combination offers plus benefits. Illustrated with action photos; picture several models. Tractor Div., Allis-Chalmers Mfg. Co.

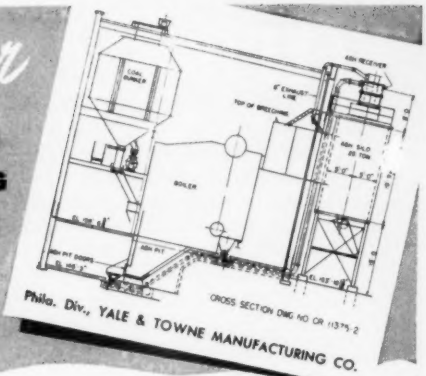
269 Coal Handling Equipment — Modern equipment for the storage and handling of coal and ash is presented in 24-pp Bulletin 300. Illustrated, covers concrete and tile silos, cylindrical steel tanks, suspended bunkers. Gifford-Wood Co.

INSTRUMENTS AND CONTROLS

270 Electronic Control System — Bulletin A-701 introduces company's Autronic system, a miniature all-electronic system for controlling pressure, temperature, flow and level, intended for use in chemical processing plants, refineries, central stations, other applications where fast, accurate control is required. The Swartwout Co.

271 Instruments Control Systems — Twelve-pp Catalog 513 presents manufacturer's line of instruments, control systems, regulating valves and desuperheaters. Covers draft and pressure instruments, boiler meters, recorders, thermometers, regulators, combustion controls, pump controls and many others. Republic Flow Meters Co.

Another COAL and ASH HANDLING INSTALLATION by BEAUMONT



Here's one of the many efficient coal and ash handling installations—designed, manufactured, installed by Beaumont. The above system is operating at the Philadelphia plant of Yale & Towne Manufacturing Company. This plant saved both time and expense—through one-contract-economy . . . But you're right! It's up to us to convince you of the advantages in a Beaumont installation: So let us send you our folder of typical installations. Write to:

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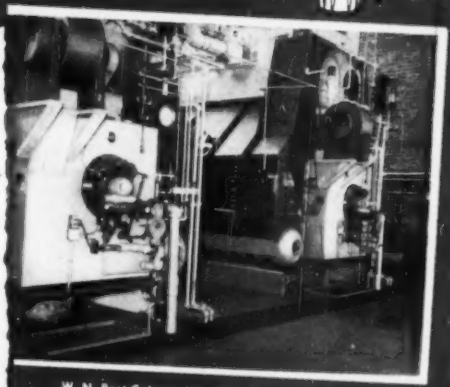
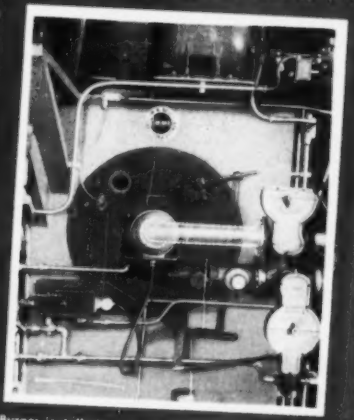


W. N. Best Calorex Roto-Cup Burners with complete automatic firing control installed at Lily-Tulip Cup Corporation, Terminal Warehouse, Bronx, N. Y.



Burner installation at Lily-Tulip Cup Corp., Springfield, Mo., plant. W. N. Best Calorex Roto-Cup Burners with controls are quickly interchangeable for either gas or oil fuels. Porcupine gas diffuser cartridge, interchangable with oil atomizer cartridge, is shown in phantom.

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For more data circle 576 on Post Card

272 For Combining Control Signals — The improved design of company's Ratio Totalizer is described and pictured in color in 8-pp Bulletin 5452. This simplified versatile mechanism is a pneumatically operated control for combining input control pressures and spring forces, and producing an output control pressure based on addition, subtraction, multiplication, division or other functions. Hagan Corp.

273 Meters and Control Systems — Integrated control systems and individual meters for these systems are shown in 12-pp Bulletin 15-H. Boiler, combustion and feedwater controls are singled out for special attention, complete with photographs and schematics. Also included are measurement requirements for steam temperature, condensate, boiler feed pump control. Bailey Meter Co.

274 Supervisory Instruments — Catalog 90-2, "Supervisory Instruments for Power Generation," consists of 41 pp on the instrumentation involved in generating stations. Separate sections cover steam generation instrumentation, turbine and generator instrumentation, electrical distribution instrumentation and diesel engine instrumentation. Measurement of temperature, pressure, flow, power generation and other variables discussed. Brown Instruments Div., Minneapolis-Honeywell Regulator Co.

Postage-free cards for ordering catalogs and bulletins are provided on pages 38 and 116

275 For Practical Men — This 24-pp pocket-size booklet presents insulation testing in simple language. Packed with maintenance hints, explains electrical insulation, tells how it can be tested and what makes it go bad. It describes the Megger insulation tester and justifies its cost in long run economy. James G. Biddle Co.

276 Industrial Thermometers — Catalog 125, 28 pp, presents ordering data on a wide range of industrial thermometers, giving scale ranges, dimensions and prices. Features company's Adjust-Angle thermometer designed for use at any angle front to back, left or right, through a 180 deg arc. Gives construction details and advantages of this adjustable-stem type instrument. Weksler Thermometer Corp.

277 Temperature Regulators — Twelve-pp Bulletin T, Catalog 80, describes manufacturer's line of regulators for controlling temperature of liquids and gases, giving their applications, operating characteristics, construction specifications, dimensions. Foster Engineering Co.

278 Pressure Regulator — Bulletin 1-B, 8-pp discusses design, operation and applications of a super-sensitive pressure regulator; shows typical installations. Also covers a compound regulator for controlling back pressure relief valve. Atlas Valve Co.

279 Easy Reading Gage — An all-hydrostatic remote reading gage for boiler water and other liquid levels is

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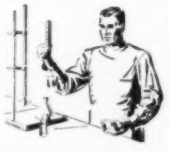

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described in Catalog 500, Section CO. Pictures improved visibility, other advantages offered by this gage, explains operation. The Reliance Gauge Column Co.

ELECTRICAL

280 Electrical Maintenance Tips — Booklet B-5477, 28 pp, gives a complete outline of preventive electrical maintenance. Discusses general maintenance programs designed to reduce shutdown time and treats in detail the maintenance of power equipment. A suggested schedule of work and cleaning on power equipment is presented in chart form. Essential information on preventive maintenance for turbines, generators, switchboards, motors, controls is provided. Westinghouse Electric Corp.

281 Wire, Cable Ordering Guide — Newly-released General Catalog W-52-3, 186 pp, presents more than 500 different types of wires and cables. Contains comprehensive data on construction and operating characteristics for control and signal cables, cables for construction work, telephone wire and cables, and portable cords. A detailed technical engineering data section is also included. United States Rubber Co.

REFRACTORIES, INSULATION

282 Refractory Brick — Electric furnace fused refractory bricks and their use is described in Form 862, 16 pp. Gives installation procedure on a high quality silicon carbide brick for boiler furnaces and gas generators. Also provides information on a fused aluminum brick. Norton Co.

283 Heat Insulation — This 8-pp booklet on hydrous calcium silicate insulation is illustrated with graphs, tables and drawings showing the numerous ways in which this insulation is used in industrial and commercial projects for temperatures up to 1200 F. Lists wide selection of shapes and sizes to insulate tubes and pipes from ¼ to 72 in. dia and vessels from 72 in. to 60 ft, also flat surfaces. Gives data on physical characteristics, recommended thicknesses. Kaylo Div., Owens-Illinois Glass Co.

284 Industrial Insulations — Just released, this 20-pp catalog describes insulating materials covering the temperature range from — 150 to 1800 F, and including cement, block, blanket, felt and pipe covering. Complete with thermal-conductivity graphs and heat loss charts, catalog also shows list prices. Brief application descriptions included, also typical uses, sizes, packaging, densities. Baldwin-Hill Co.

285 Heat Insulation Data — This is a 12-pp illustrated engineering and specification manual describing applications for 85 per cent Magnesia heat insulation. Provides data on heat savings per pipe thickness, for heat ranges to 600 F. Includes charts for determining thickness standards for pipe covering, with tables for heat calculations. Mundet Cork Corp.

TOOLS

286 Pipe Tool Book — This catalog and data book gives information on pipe and bolt machines, power units, ratchet threaders, reamers and cutters, other power and hand tools. Includes "operating guide" Beaver Pipe Tools.

287 Rotary Tube Cleaners — Bulletin R-105 presents air and water driven rotary tube cleaners and cleaner accessories. Illustrates several models and heads, discussing special features. Roto Div., Elliott Co.

288 Tube Cleaners — Catalog 76-A provides 48-pp of information on manufacturer's line of tube cleaners. Following equipment selection and operating hints, this practical catalog describes and pictures cutter heads and drill heads, brushes, and motors, giving sizes, application information. Electrically driven equipment, air valves, hose, lubricators presented. Thomas C. Wilson, Inc.

OTHER EQUIPMENT

289 Turbine Generators — Bulletin H-18, 40 pp, covers turbine-generators of 500 kw and above, pictures nearly 50 turbine-generator installations, both utility and industrial. Brief discussions of generator and exciter cooling methods are included. A reference section offers detailed drawings showing a typical installation arrangement. Elliott Co.

290 Air Preheaters — Illustrated Bulletin A-11610, 8 pp, defines air preheat and explains its benefits in terms of increased efficiency and capacity and flame stability. Provides general description of company's Ljungstrom preheater. The Air Preheater Corp.

291 The ABC of CO_2 — An interesting text covering role of carbon dioxide in combustion efficiency, 16-pp illustrated Bulletin 452 discusses theoretical vs practical perfection of combustion

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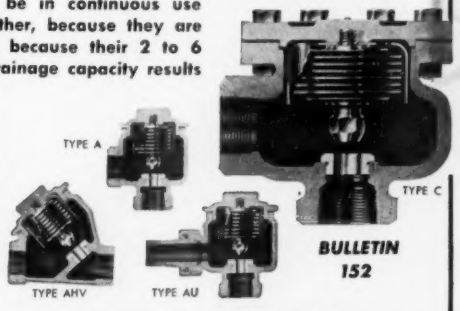

BULLETIN 152

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TRAPS · VALVES · FLOATS

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and tells how to determine percentage of CO_2 in flue gases. CO_2 as a basis for figuring heat and fuel losses is also described and method of determining such losses explained. The Hays Corp.

292 Mechanical Draft Fans — Mechanical draft fans for both forced and induced draft service are described in 20-pp Bulletin 168. Illustrated with drawings of typical fan types and photos of installations, includes performance curves showing efficiencies of various types of fans. The Green Fuel Economizer Co., Inc.

293 Dowtherm Vaporizer — Bulletin No. 48-2, describing manufacturer's Type "A" Dowtherm Vaporizer, tells how this unit is designed to evaporate Dowtherm to provide dependable operation at maximum temperatures. The Wickes Boiler Co.

294 Heat Exchanger for Process Industries — Bulletin HF-101, 8 pp, introduces the Holo-Flight Processor, a new heat exchanger. Tells how it affords control of the flow of material as to duration of treatment, and control of the quantity and temperature of heat exchange agent. Western Precipitation Corp.

EXCITATION SYSTEMS

(Continued from page 112)

the kind usually given to rotating machinery, static regulators require almost no maintenance. The components employed in magnetic regulators are not subject to wear or failure under normal operating conditions, and are characterized by extremely long life. Static regulators may also be removed from service at any time, without disturbing machine load or terminal voltage, to place the machine under manual control by following a simple and brief procedure. Performance of this type of regulator is excellent; steady state voltage regulation of plus or minus one-half of one per cent and very rapid speeds of response. Static regulators may be used with machines which operate under any type of load condition.

Auxiliary Functions

Modern regulators are frequently required to perform functions other than their fundamental task of regulating the terminal voltage of a synchronous machine. With the addition of simple and compact auxiliary apparatus, they will divide reactive kva between automatically regulated machines in proportion to the machine ratings. Additional equipment may be obtained which will enable a regulator to limit the field of armature current or temperature of a machine to a maximum safe value. Static regulators are usually supplied with devices for avoiding under-excitation of a machine by preventing the exciter voltage from being materially lowered below a given safe value, or by limiting the under-excited reactive kva of a machine with relation to its kw load. The device which fulfills this function is called a minimum excitation limit, and permits maintaining definite margins of stability always.

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50,000 LB PER HOUR WATER-TUBE BOILER

Forged steel, sectional header, cross drum, water tube boiler, including steam trim — designed for 450 psi pressure, 600 degrees superheat, with 7200 sq ft heating surface. Delivery in first quarter of 1953.

New forged steel sections with generating and circulating tubes supplied by Babcock & Wilcox installed in 1949. New superheater elements purchased from Combustion Engineering-Superheater, Inc. installed in 1949.

This boiler now in service in Middle West steel plant and is being removed because of expansion program involving larger capacities. Priced attractively on "as-is", "where-is" basis for an early acceptance. Due to sectional design, low cost proposals can be provided for dismantling and re-erection. Write to Box 1675, POWER ENGINEERING, 110 S. Dearborn St., Chicago 3, Ill.

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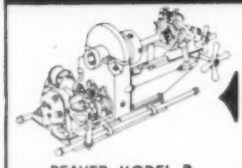

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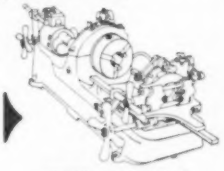
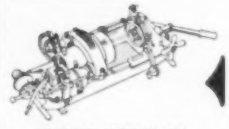
A rugged, Heavy-Duty Machine. Range ⅛ to 2". Up to 12" with Geared Tools and Drive Shaft. Bolts ¼ to 2"—Weight 365 lbs.



BEAVER MODEL-B
A Middleweight Utility Machine. Range ⅛ to 2". Up to 8" with Geared Tools and Drive Shaft. Bolts ¼ to 1½"—Weight 235 lbs.



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A Lightweight Portable Machine. Range ⅛ to 2". Up to 8" with Geared Tools and Drive Shaft. Bolts ¼ to 1½"—Weight 185 lbs.

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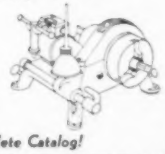
A sturdy little Power Drive that converts Hand Tools into Power Tools—Range ⅛ to 2". Up to 8" with Geared Tools and Drive Shaft. Bolts ¼ to 1½"—Weight 140 lbs.



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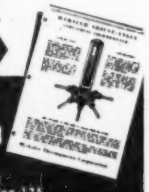

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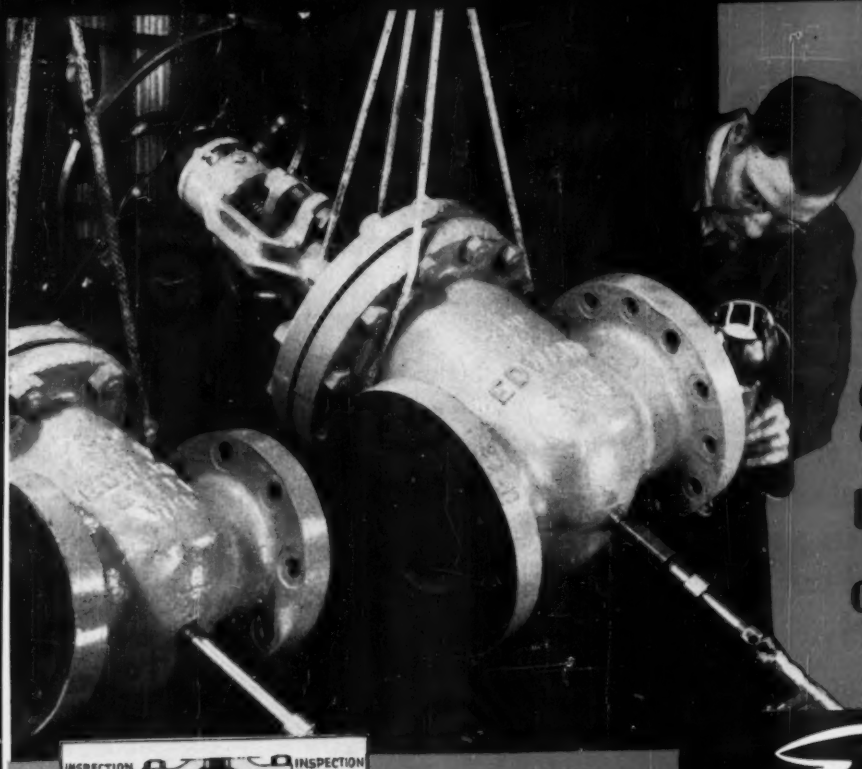
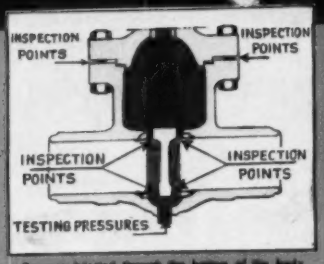
For more data circle 582 on Post Card

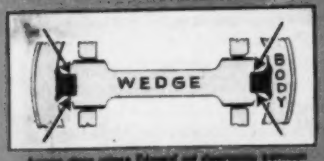


EXCLUSIVE TEST METHOD PROVES *Simultaneous* tight seating of both faces of

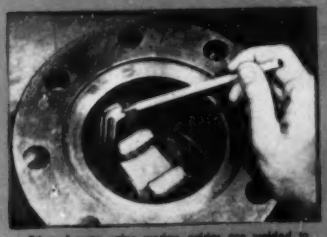
Edward GATE VALVES



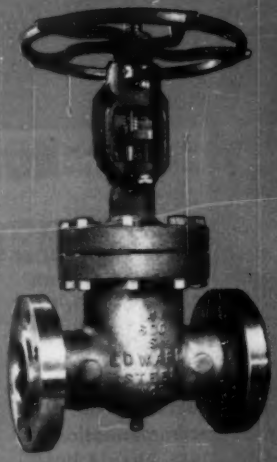
Pressure injected through the bottom of the body surrounds seats, yet leaves both ends open for simultaneous inspection in Edward testing method.



Arrows show where Edward *and* downstream pressure wedge and guide ribs to eliminate wedge drag on seats. With Edward gate valve, partial turn of handwheel transfers load from seats to wedge guides.



Edward gate valve wedge guides are welded to body after seats are in place; therefore moving parts are accurately located. Seat rings are also welded in to prevent leakage between seats and body.



When Edward engineers began the design of a new series of steel gate valves, they tested other makes. Many of them were tight on one seating face or the other, but few were tight on both faces.

To build really tight gate valves, Edward engineers discarded the conventional method of casting guide ribs as part of the body and instead developed a new technique for welding the ribs into the body *after the machined seating faces were in place*. This, they demonstrated, reduced machining tolerances, eliminated wedge drag on the seating faces, and cut wear. They were also sure it meant a tighter valve.

But how to prove it? The result was the testing method shown above. Now, *all* Edward gate valves are tested with both ends open for simultaneous inspection, and both seating faces must be tight simultaneously.

The new Edward gate valves incorporate many other plus-value features, such as welded-in seats, one-piece bonnets, ball bearing yoke bushings in most sizes, and Stellite faced seating surfaces. With Edward, these features are standard construction.

For more details write for Catalog 12-E.

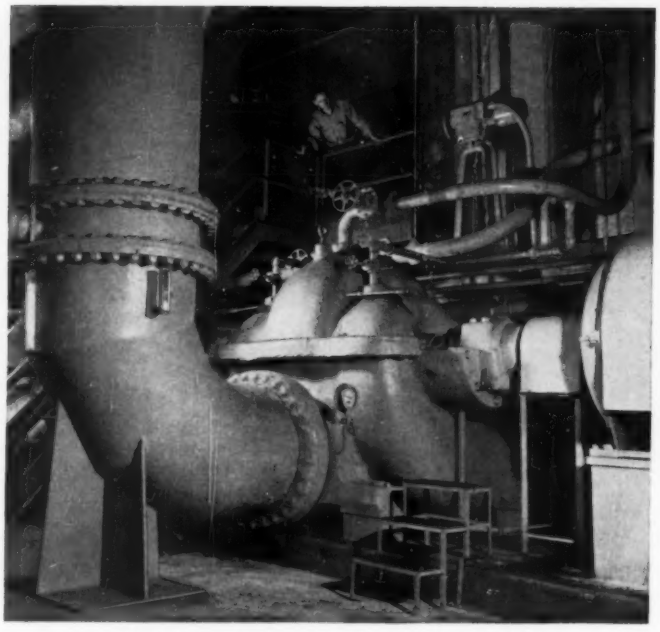
Edward Valves, Inc.

SUBSIDIARY OF RICHMOND MANUFACTURING CO. EAST CHICAGO, INDIANA

220 West 144th Street

Why a Horizontal Circulating Pump May Be Your Best Buy

Advantages of horizontal design sometimes overlooked because of low first cost of vertical units. Maintenance costs may override initial cost differential.



Allis-Chalmers 42 x 36 condenser circulating pump installed at Midwest power plant in 1950.

TODAY, many power plant condenser circulating pumps are of the vertical design. The vertical design is usually used because it requires small floor space and is less expensive to build and install. However, this low first cost does not necessarily mean that the vertical design will give lowest cost per gallon pumped over the years.

The horizontal design does require more floor space and it is more expensive to build and install. Maintenance is so much easier and less expensive on the horizontal unit that every application should be studied to determine which is actually the more economical unit in the long run.

Low Maintenance Costs

Horizontal pumps generally are less expensive to maintain for a number of reasons. The bearings are out in the open where they can be inspected daily. If a bearing does show signs of weakness, corrective measures can be scheduled for off-peak hours since it will usually give several days warning before going out completely. Also, the short and rigid shaft of the horizontal unit is less susceptible to vibration and whipping under the unbalanced loads that sometimes occur in circulating service.

Servicing the horizontal unit is much easier, faster and less expensive than servicing the vertical unit. One or more bearings on the vertical unit are completely under water, which often contains sand and silt.

Unbiased Recommendations

Allis-Chalmers builds both horizontal and vertical circulating pumps and has had many years of experience with both types. The Allis-Chalmers District Office Representative is fully qualified to discuss your power house pumping problems. He can make intelligent and helpful suggestions on pumping and many other problems in power plant design and operation. When you have a problem, discuss it with him. For more information on Horizontal Circulating Pumps, write for Bulletin 08B6146, Allis-Chalmers, Milwaukee 1, Wisconsin. A-3899

ALLIS-CHALMERS

For more data circle 590 on Post Card

For more data circle 584 on Post Card

POSITIVE! EFFICIENT! SAFER!

VALVE CONTROL AT LOWEST COST!

Babbitt
—Adjustable—
SPROCKET RIM
with Chain Guide

INSTALLED, AND OPERATING, IN ONLY A FEW MINUTES

● Here's easy, convenient, instant control of overhead, out-of-reach valves—right from the floor! No expensive apparatus! No switches! Nothing to break down when most needed! BABBITT Adjustable Sprocket Rim with Chain Guide, with only four simple parts, gives you positive efficient valve control at lowest cost!

● Prevents accidents, prevents waste, provides efficient control, and saves money. A range of 10 ADJUSTABLE sizes fits all valve wheels with rising or non-rising stems, from 2 to 30 inches in diameter.

Distributors in Principal Cities, or send for Catalog Folder PE-2 and name of nearest distributor.

BABBITT STEAM SPECIALTY CO.
1 Babbitt Square
NEW BEDFORD, MASSACHUSETTS

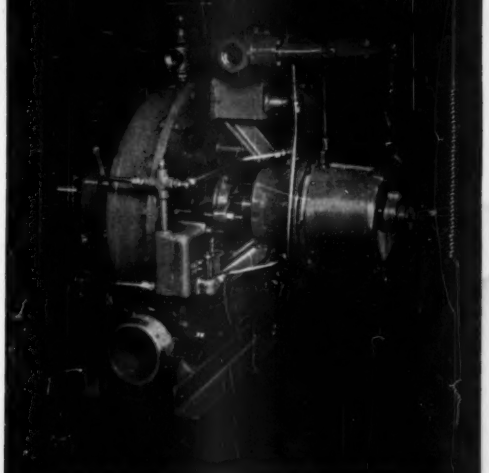
Sign Your

DECLARATION OF INDEPENDENCE

☆

Buy
U. S. Savings Bonds!

Wing



STEAM TURBINES

OPERATING RANGES

	Standard	High Pressure
MAXIMUM BHP	100	150
MAX. STEAM TEMP.	525° F	750° F
MAX. PRESSURE	275 lbs.	600 lbs.
BACK PRESSURE up to	50 lbs.	50 lbs.
SPEEDS up to	4000 RPM	4000 RPM

SPECIFICATIONS

ROTOR: All Steel
BUCKETS: Nickel Steel
NOZZLES: Bronze, Stainless Steel or Monel depending upon Steam Conditions
PULLEY DRIVE: Separate Jackshaft Coupled to Turbine
LUBRICATION: Filtered Oil or Grease
GOVERNORS: Overspeed Trip & Speed Regulating
STUFFING BOXES: Split removable, packed with semi-metallic packing
BEARING CAPS: Bearings are mounted in separate housings attached to main castings
VERTICAL SHAFTS: Available in all sizes
ROTATION: Clockwise or counter-clockwise

L. J. Wing Mfg. Co.
Vreeland Mills Road, Linden, New Jersey
Factories: Linden, N. J., Montreal, Canada
Offices in Principal Cities

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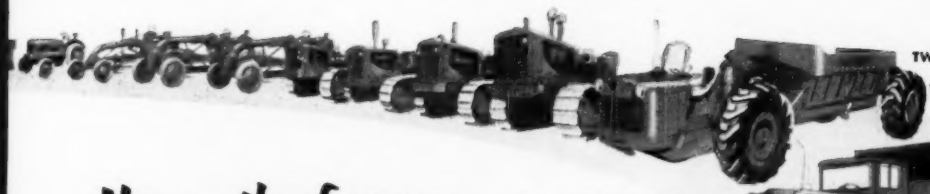
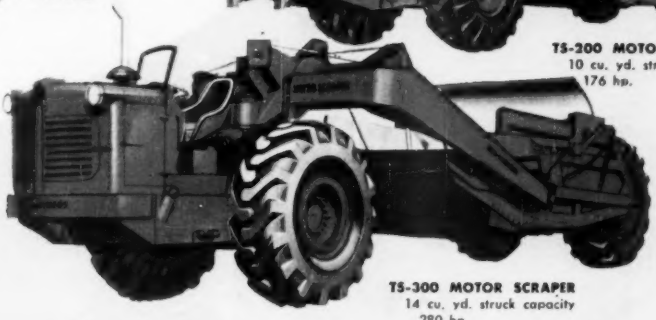


TW-300 MOTOR WAGON
Bottom Dump
14 cu. yd. struck capacity
280 hp.

Now... the famous MOTOR SCRAPER joins the A-C line

TR-200 MOTOR WAGON
Rear Dump
11 cu. yd. struck capacity
176 hp.

TS-200 MOTOR SCRAPER
10 cu. yd. struck capacity
176 hp.



TS-300 MOTOR SCRAPER
14 cu. yd. struck capacity
280 hp.

...the Finest Line on Earth

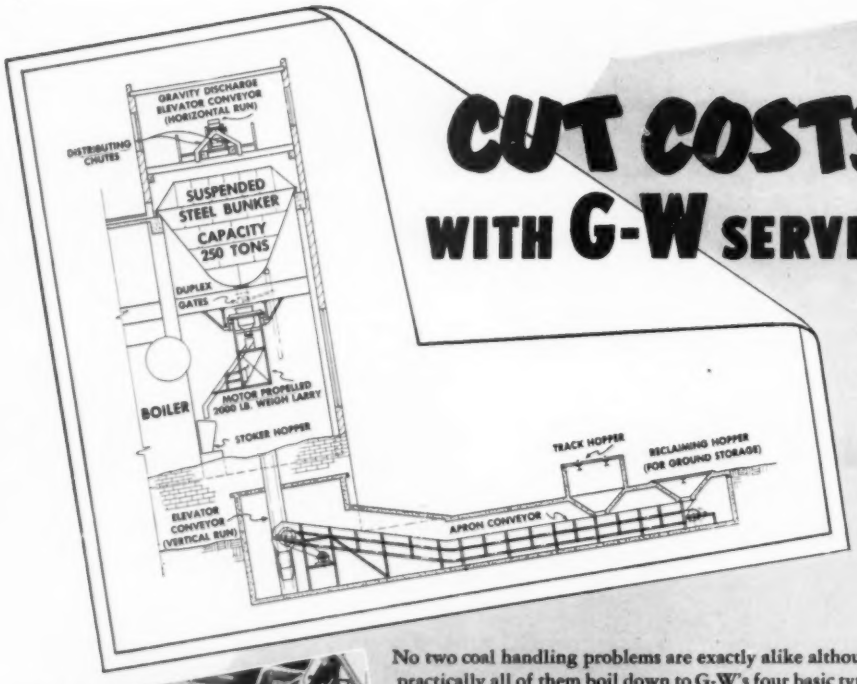
In order to serve you more completely, Allis-Chalmers has extended the *Finest Line on Earth* by adding the famous MOTOR SCRAPERS and MOTOR WAGONS formerly manufactured by LaPlant-Choate. This customer-accepted line meets A-C's 4-point quality requirements in every way.

These big self-propelled units are *designed for your job* . . . easy loading, high-speed hauling and quick, clean ejection. They're *built to take it* . . . job-tested, job-proved through years of use all over the world. Like Allis-Chalmers' other equipment, the MOTOR SCRAPER is *easy to operate . . . simple to service.*

Today's jobs require a more careful selection of equipment. That's why you'll be money ahead if you make your nearby industrial A-C dealer your headquarters for crawler tractors, motor graders, MOTOR SCRAPERS and MOTOR WAGONS. Stop in soon to discuss your job requirements and see his complete parts and service facilities.

ALLIS-CHALMERS
TRACTOR DIVISION — MILWAUKEE 1, U. S. A.

CUT COSTS WITH G-W SERVICE



G-W conveyor system with capacity of 60 tons per hour. System consists of a Rail and Truck Hopper, a 30-inch Apron Conveyor, Gravity Discharge Elevator, 250-ton Suspended Steel Bunker and a 2000-lb. Weigh Larry.

No two coal handling problems are exactly alike although practically all of them boil down to G-W's four basic types of storage and handling.

For example, at a large U.S. Government arsenal, G-W designed and installed the suspended steel bunker with a gravity discharge bucket elevator shown at left. Coal is carried on the upper run of the conveyor, permitting free access to machinery and maximum bunker capacity. A cab-type weigh larry with recording beam provides clean, economical operation.

4 BASIC WAYS TO CUT COAL HANDLING COSTS

No matter what your coal and ash handling problem is, from one of 4-basic types... Concrete Silos, Vitrified Tile Silos, Cylindrical Steel Tank, and Suspended Steel Bunker... G-W engineers can install the most efficient and economical storage and automatic handling system to fit your requirements of space, capacity and initial cost. Their recommendations to you, will be based on more than 140 years of design and engineering experience and on the performance records of hundreds of successful installations.

Fourteen interesting case histories, based on these 4 G-W basic designs, are described in Bulletin No. 300. Write for your copy, today.

GIFFORD-WOOD CO.

SINCE 1814

NEW YORK 17
420 LEXINGTON AVE.

Factory:
Hudson, N. Y.

CHICAGO 6
565 W. WASHINGTON ST.

G-W HANDLES IT... faster • easier • cheaper

6349

For more data circle 586 on Post Card

LIGHT

...but what a Lift!

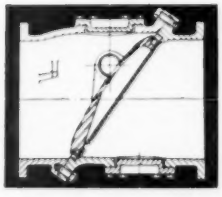
...that's the secret of this All-Time Low in Head Loss...

Take a close look at that Tilting Disc. See the special Aerofoil design that means light weight... and minimum resistance to flow in the open position.

Look again, and see how this Tilting Disc... pivoted just above center... is practically balanced, so is easily held open... and then cushions quietly to a drop-tight seat. This means no slamming under usual piping arrangements, no opening of pipe joints, no wear of valve parts.

And it means 65% to 85% less head-loss than with regular swing-type check valves. *Send for proof*... check the certified flow charts in Chapman's Bulletin No. 30. Write for a copy to:

The Chapman Valve Mfg. Co., Indian Orchard, Mass.



Cross-section of the Chapman Tilting-Disc Check Valve. A feature of the design is that the disc seat lifts away from the body seat when opening, and drops into contact when closing, with no sliding or wearing of the seats.

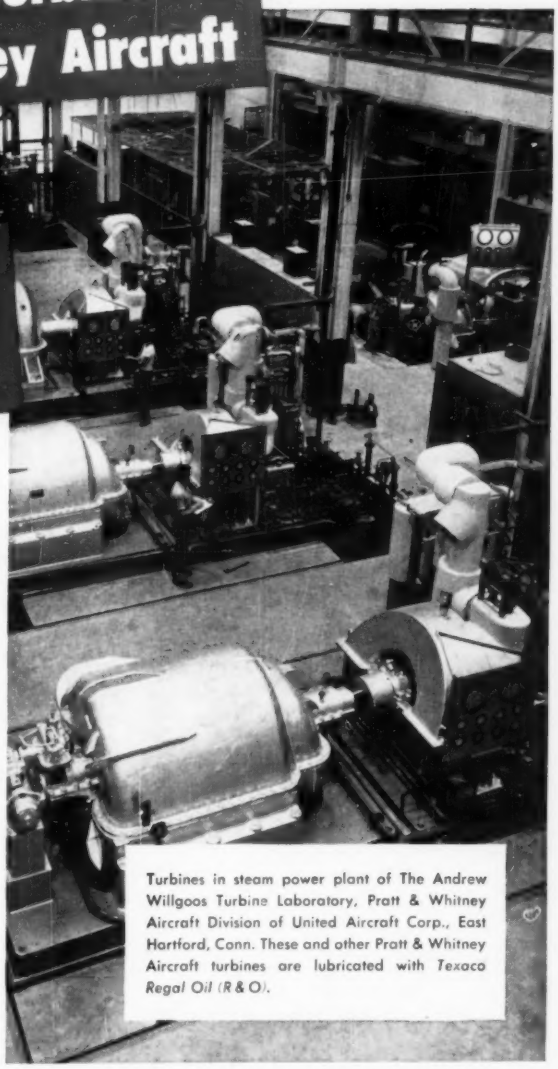
CHAPMAN (TILTING DISC) **CHECK VALVES**

For more data circle 588 on Post Card

EXTRA PROTECTION

assured these turbines at Pratt & Whitney Aircraft

They're lubricated with TEXACO REGAL OIL (R&O)



Two years ago, Pratt & Whitney chose *Texaco Regal Oil (R&O)* for these turbines. Since then they have been getting an extra margin of safety, an extra measure of dependable performance. With *Texaco Regal Oil (R&O)* there has been no sludge, no rust, no foam to interfere with operation.

Texaco Regal Oil (R&O) is the world-famous Texaco Regal Oil *improved* with special Texaco additives and special Texaco processing. Thus, *Texaco Regal Oil (R&O)* is outstanding in preventing sludge, rust and foam.

With *Texaco Regal Oil (R&O)* you can count on the free flow of clean oil that assures normal bearing temperatures and instant governor response. You can count on an extra long oil service life, too. There is a complete line of *Texaco Regal Oils (R&O)*, suitable for every type and size of turbine, for every operating condition. They meet the stringent requirements of all leading turbine builders.

Let a Texaco Lubrication Engineer explain the many benefits you can gain by using Texaco Lubrication throughout your plant. Just call the nearest of the more than 2,000 Texaco Distributing Plants in the 48 States, or write The Texas Company, 135 East 42nd Street, New York 17, N. Y.

Turbines in steam power plant of The Andrew Willgoos Turbine Laboratory, Pratt & Whitney Aircraft Division of United Aircraft Corp., East Hartford, Conn. These and other Pratt & Whitney Aircraft turbines are lubricated with *Texaco Regal Oil (R & O)*.

TEXACO Regal Oils (R&O)

FOR ALL TURBINES

Faithfully yours 50 *for Fifty Years*

TUNE IN . . . TEXACO STAR THEATER starring MILTON BERLE, on television Tuesday nights. METROPOLITAN OPERA radio broadcasts Saturday afternoons.

For more data circle 589 on Post Card